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The Culebra cut is the controlling feature in the question of time necessary to complete the canal. If a sea-level canal be dug the cut will have a maximum depth of 360 feet, and 186 million cubic yards of material must be excavated. It will take two years to install the plant and six to eight years to complete the cut.

A Portion of the Great Culebra Cut, Eight Miles in Length, Through the Divide.

HISTORY AND PRESENT STATUS OF THE PANAMA CANAL.—[See page 442.]

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NEW YORK, SATURDAY, JUNE 3, 1905.

The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

ALTERNATIVE PLANS FOR THE PANAMA CANAL.

An engineering work of the great size and complicated character of the Panama canal should be the subject of most exhaustive examination before the final plans for its construction are adopted. To the lay mind it might seem that already time and expense enough had been incurred in preliminary investigations; but to the engineer it is well known that in hydraulic works of the magnitude of the Panama canal, it takes years to acquire that intimate knowledge of climate, topography, and sub-surface conditions, which is absolutely essential before he can say, "I will build this work upon such a plan, for such a cost, and within such a time."

That the last word must not be too hastily spoken in the matter of selecting the general plan of this canal, is shown by the fact that Mr. Lindon W. Bates, one of the most experienced of American engineers in work involving heavy excavation, has recently presented to the President two alternative plans for the construction of the canal, which have so much to recommend them that they are certain to receive most careful consideration from the canal commission. The leading illustrated article of this issue gives a clear account of the plans for a sea-level canal that are tentatively favored by the present commission; and they form the basis of comparison in the present sketch of Mr. Bates's suggestions. The first of his projects involves the construction of two large terminal lakes, one extending from Mindi near the Atlantic Ocean to Bohio, a distance of 12 miles, and the other reaching from La Boca to Pedro Miguel, a distance of 5 miles. These two large reservoirs would afford about 17 miles of lake navigation, and because of the higher speed at which ships could travel in crossing them, would reduce the time of transit three hours below that which would be necessary to pass through the proposed sea-level canal. Entrance to the lake at the Atlantic end would be by locks with a lift of about 25 feet. One advantage of the lake would be that a large area of swamp land would be covered by fresh water, and a fine interior harbor created for vessels; moreover, all excavation of the channel along the sailing route could be performed by floating dredges. The canal between the two lakes, thus formed, would be excavated through the divide at the same level as the lakes, there being thus a single summit level of plus 20 from the Mindi dam on the Atlantic to La Boca dam on the Pacific. At Gamboa, which is about midway between Bohio and Pedro Miguel, Mr. Bates proposes, for control of the Chagres, the construction of a dam provided with under-sluiceways, with provision for discharging one-half of the flood waters of the Chagres River to the Pacific and one-half to the Atlantic. The great advantage of this plan over the one proposed by the present chief engineer of the canal is that it will be possible to receive the sudden floods of the Chagres in a reservoir that is normally empty, and permit them to escape at will.

The second project offered by Mr. Bates provides for four locks, with a summit elevation 52.5 feet above mean sea level. This plan, in addition to dams at the Atlantic and the Pacific end of the canal, calls also for the erection of dams at Bohio and at Pedro Miguel, and the creation of a lake at Bohio with a surface level of 52.5, which is entered by locks with a lift of about 30 feet, and which extends for 15 miles to the foot of the Culebra divide. The canal is cut through the divide with the same surface level as that of Bohio Lake, descent being made at Pedro Miguel to the 20-foot level, which extends from Pedro Miguel to the Pacific. Briefly stated, the first scheme will consist of two lakes and a connecting length of canal, all at an elevation of 20 feet above mean sea level. The second scheme will consist of two terminal lakes at an elevation of 20 feet above mean sea level, and a summit lake and length of canal with an elevation of 52.5 above mean sea level.

A comparison of these two projects of Mr. Bates with the sea-level canal recommended by the present chief engineer, shows that unless there are some physical features that would prevent its execution, either of the new plans would have several important points of advantage over the sea-level plan. For in the first project there would be 17 miles of lake navigation, and in the second 26 miles (over one-half the length of the canal), as against an all-canal navigation in the case of a sea-level canal. The time of transit of large vessels would be reduced from say 12 hours to about 9 hours, and the time of completion from ten years, which is the most optimistic estimate of the chief engineer, to eight years. Finally, judged on the question of cost, Mr. Bates estimates that there will be a saving of about $85,000,000.

The fact that an eminent engineer, as the result of an independent investigation of the problem, should be able at this late day to present a scheme that has so many admirable features, certainly shows the wisdom of the President in determining to call in some of the most eminent engineers of Europe to act in a consulting position with our own engineers in choosing the final plans for the canal. So monumental is this work, so far-reaching will be its effects upon the commerce of the world, that the plan upon which it is built should be not merely a good one, but the very best possible for the conditions.

AN ATTACK ON THE WIRE-WOUND GUN.

An ex-lieutenant of the British navy has created not a little stir in naval circles by writing a series of letters to the London Times, in which he tries to throw discredit upon the wire-wound gun. These letters were based upon the fact that some guns of this type in the British navy had developed a crack in the liner, the thin inner tube which carries the rifling, and had been sent to the gun factory to be relined. It must be admitted that on the face of it the mere statement that some 12-inch guns had "cracked," sounds ominous. But when we come to examine into the construction of these guns, the location of the cracks, and their effect upon the strength of the gun, we find that the defects are of such minor consequence that the strength of the guns is not in the least affected. As a matter of fact the very powerful powder, cordite, used in the British navy exercises such a rapid scoring effect on the liner, that after a certain number of rounds have been fired, the guns must be returned to the factory for relining. The scoring of the gun is the penalty which the authorities are willing to pay for the sake of using a powerful explosive, whose bulk is not much more than half as great as that of the less powerful propellants which do not score the guns so severely.

The 12-inch wire-wound gun is assembled in the following manner: First there is the inner tube or liner, which is placed there to carry the rifling grooves and to protect the gun proper from the action of the white-hot powder gases. Then comes the main tube, or A tube, as we should call it in this country, a thick, heavy tube extending the full length of the gun from breech to muzzle, whose object is to carry the 100 miles of wire which is wound upon the tube, and which constitutes the actual strength of the gun. The wire is wound at a tension so great that the metal of the tube is thrown into a state of initial compression. This compression is such that when the gun is fired, the whole of the bursting or tangential stress is immediately transmitted to the wire, which has an ample margin of strength to take care of any legitimate pressures that are set up by the powder. In the English guns the A tube is forged and bored and turned from a single piece of metal. In the Brown wire gun, as manufactured in this country, the A tube is formed of a series of involute, overlapping, thin steel plates, and in this gun the wire is wound at such great tension on the tube that when the gun is fired, the metal of the tube never even passes from a compressive to a tensile condition. In both guns the wire winding is covered from breech to muzzle with a pair of outer steel tubes which serve to protect the wire from injury by shot or shell. In the gun as thus made up, the longitudinal stresses tending to pull the gun apart in the direction of its axis are taken care of by the inner barrel or A tube, and by the outer hoops, which are locked into one another. The bursting stresses are resisted by the wire-winding, assisted by the outer hoops, and the inner tube or liner is not called upon, in estimating the strength of the gun, to resist either of these stresses, tangential or longitudinal. So true is this, that the liner might be split through its entire length, as we believe happened in some of the guns in question, without impairing the strength of the gun.

The SCIENTIFIC AMERICAN holds no brief for the wire-wound gun, and we merely desire to place the full facts of the case before the public, especially at the present juncture, when the gallant little Japanese navy is having to depend upon guns of this type in the most momentous crisis of the war. We understand that the wire-wound guns of the Japanese have given excellent service, and that, in spite of the severe service to which they have been put, there has been no case of failure. As to the life of the wire-wound gun, it appears that when the first of the type were made for the "Majestic" class of battleships of the British navy, it was estimated that the inner tubes would not last for more than sixty to eighty rounds. But, according to the Admiralty, the equivalent of 162 rounds has already been fired from one of these guns, and others which have fired the equivalent of over sixty full charges, are still perfectly serviceable. In this connection it is of interest to note that the highest velocity yet attained in this country for a gun of large caliber was recorded not long ago in the army tests at Sandy Hook of the new Brown wire gun, when some rounds were fired with a velocity of over 3,300 feet per second. Another wire-wound gun, designed by Gen. Crozier for the army, is nearing completion, and will shortly be subjected to test.

THE PREPARATION OF SURFACES FOR PAINTING.

In preparing a panel of wood or cardboard for the reception of a painting in oil colors, it is desirable to make the ground agree with the layer which forms the painting in respect to expansion by heat and moisture, otherwise cracks are sure to occur in time. The panel may be painted with boiled linseed oil, which penetrates to a certain depth and is hardened by oxidation to a thin, tough coating, identical with the hardened oil in which the pigments are imbedded. A painting on such a ground may be exposed to great variations of temperature without danger of cracking. The preparation takes time, as the oil must become quite hard before the painting is begun. It is advisable to oil both sides of the panel and the edges, to prevent danger of warping from dampness. The best way to oil panels in quantity is to place them on edge, separated by small blocks of wood, in a tin vessel which is then filled with well-boiled oil, heated gradually from beneath to 110 deg. or at most 120 deg. C. (230 deg. to 248 deg. F.) and allowed to cool. The pores of wood and cardboard are filled with air, and both contain large quantities of water, the moisture in thoroughly air-dried wood amounting to 20 per cent by weight.

During the heating the air is first driven out, and then the water, which at 120 deg. C. may be assumed to be entirely expelled, and during the slow cooling the external air pressure forces the oil so deeply even into hardwood that panels a quarter or a third of an inch thick are saturated throughout. The panels are taken out and allowed to drain, and the excess of oil is removed with a cloth or brush. They are then kept standing on edge, without touching each other, for several months, in order to harden the oil in the interior as well as on the surface.

Paintings on panels thus prepared are not only uninjured by variations in temperature and humidity, but they may be cleaned by washing and are not attacked by insects, which often ruin unprepared panels.

Metallic grounds are little used by artists, although very small paintings are sometimes executed on plates of copper. Such plates, though strong, durable, and proof against dampness, are peculiarly liable to produce cracks in the paintings executed on them, because they expand or contract so greatly and so quickly with every change of temperature. This defect, however, can be remedied to a great extent by giving the metal a tough, elastic coating, for which purpose linseed oil is again employed. The plate is roughened with a fine file, slightly polished with pumice stone, washed, dried, and immediately painted very thinly with hot oil, which penetrates into all the irregularities and, when hardened, adheres firmly, the adhesion being increased by chemical action of the acids in the oil upon the copper, which thereby assumes a greenish tint. Three coats of oil are given, each of which is allowed to become quite hard before the next is applied.

The painting, therefore, rests on a tough, elastic coating of hardened oil, which protects it from the effect of expansion of the metal.

Sheet-metal signs and the lettered and decorated tin boxes in which small wares are sold soon become defaced when exposed to changes of temperature, particularly if the colors have been mixed with quick driers, as is generally the case. The process above described is too costly to be applied to most of these articles. A simpler method consists in giving the metal one coat of thoroughly boiled oil, or better drying oil, and grinding the colors in the latter without any special drier. The plates do not dry very rapidly, but this simple process is not only cheaper, but more effective in securing permanence than the use of colors ground in soft resin varnishes, as practised by some manufacturers.

Plaster and stucco are painted in both oil and distemper. The colors sink into the porous wall, and one spot may have to be repainted several times to produce the desired effect. This inconvenience is easily avoided by giving a preliminary coat of size for distemper, or of hot boiled oil for oil painting.

The finished painting should receive a coat of var-

nish or paraffin. When paraffin is used, however, the wall should be neither sized nor oiled before painting, and the colors should be mixed with a minimum quantity of thin size. When dry they are covered with melted paraffin, hot enough to sink well into the wall before solidifying, a condition which is made known by the instantaneous disappearance of the gloss. Additional coats of paraffin are then applied until a permanent gloss is produced, and the surface is finally polished with a woolen cloth. Such mural paintings are very permanent, as the chemically-inert paraffin protects both the wall and the colors.—Condensed from Der Stein der Weisen.

THE HEAVENS IN JUNE.

BY HENRY NORRIS RUSSELL, PH.D.

With the recent astronomical periodicals comes fuller information about the two new satellites of Jupiter. Thanks to the zeal of Prof. Perrine, a sufficient number of observations of each of these bodies has been obtained, before Jupiter got too near the sun to be seen by night, to enable their orbits to be roughly calculated. This makes it certain that these faint specks are really moons of Jupiter and not merely small asteroids which happened to be near him when the first photographs were taken. It will also make it easy to find the satellites again when Jupiter reappears in the morning sky by telling us where to look for them.

The results which Prof. Perrine has announced are somewhat remarkable. The sixth satellite (which is the brighter of the two) is about seven million miles from the planet, and takes about 250 days to complete a revolution. The outermost satellite previously known (the fourth) is only one-sixth of this distance from Jupiter and its period is about sixteen days.

The seventh satellite, which is much fainter, revolves in an eccentric orbit, at a mean distance of about six million miles, with a period of some 200 days.

The planes of the orbits of these two satellites are considerably inclined to that of the orbit of Jupiter, to the orbits of the inner satellites, and to each other.

They are both very small bodies. The sixth satellite, which is of the 14th magnitude, has been seen with the 26-inch telescope at Washington, and is therefore within the power of a number of instruments. The seventh satellite is estimated as 16th magnitude—about as bright as the new satellite of Saturn—and can only be seen with one or two of the very largest telescopes. They are so far from the planet that they might have remained undiscovered for centuries had it not been for photography.

From their brightness, as compared with the larger satellites, Prof. Perrine concludes that the sixth satellite is 100 miles or less in diameter, and the seventh about 35 miles.

It is not yet known whether these two new satellites revolve about the planet in the same direction as the other five. How this may remain indeterminate, when so much is known about their orbits, appears from the following considerations: We can tell by watching the satellite go once round Jupiter (or even part of the way round) how far to the left and right of the planet it goes, how long it takes to go round, and so on; but we cannot tell merely by looking at it whether it is nearer to us than Jupiter, or farther away, whether it is approaching us, or receding from us—and this is just what we need to know to determine the direction of the satellite's motion. To solve the problem we must wait a year or two, until Jupiter has moved some way along his orbit, so that we see the orbits of the satellites at a different angle. Then, by combining the two views of the orbit, we can tell which is the nearest part of it in the same way in which the stereoscope, by combining two views of a landscape, enables us to pick out the nearer objects.

It will be of great interest to see whether these two satellites go backward, like Phœbe, the outer satellite of Saturn, which they so much resemble in other ways, or have a direct motion like the general run of satellites.

The brightest objects in the evening sky are Arcturus and Mars. At 9 P. M. in the middle of this month they are both close to the meridian, Arcturus being about 20 deg. south of the zenith (in the latitude of New York) and Mars about 35 deg. lower down. The planet is brighter and redder than the star. To the right of Mars and nearly at the same level is Spica. The other stars of Virgo are higher up and farther west. Below them is the little group of Corvus. Leo lies in the west at a moderate altitude. Below him is Hydra, whose long tail stretches to the meridian under Mars. Ursa Major is high up, extending northwestward from the zenith. Castor and Pollux are still visible in the northwest and Capella is just setting still farther to the north.

On the meridian below Virgo can be seen a part of Centaurus. Its two brighter stars, which almost equal Arcturus, can only be seen from points south of latitude 30 deg.

In the southeast is Scorpio. The three stars which lie near the creature's head and the red Antares at its heart are all visible, but its long tail extends below the horizon. The tangle of stars above and to the left of Scorpio form the constellations Serpens and Ophiuchus. Through them runs a branch of the Milky Way.

Farther north is a line of fine constellations. Aquila is low in the east. Its principal star, Altair, is flanked by a smaller one on each side. Higher up and farther north is Lyra, which contains Vega, the brightest star in this part of the sky. Between Vega and Arcturus are Hercules, marked by a figure shaped like the keystone of an arch, and Corona, whose stars form a semicircle. Below Vega, to the left, is Cygnus. Cassiopeia is beneath the Pole. Cepheus on the right.

THE PLANETS.

Mercury is morning star till the 24th, when he passes through superior conjunction and becomes an evening star. He is not well seen at any time during the month.

Venus is morning star in Aries and is very conspicuous, reaching her greatest brightness on the 2d and rising between 2 and 3 A. M. all through the month.

Mars is the principal feature of the evening sky. He is on the border of Virgo and Libra, and comes to the meridian at 9.50 P. M. on the 1st and at 7.50 on the 30th. He is still quite near opposition, but is gradually receding from us, and his distance increases from 51 to 63 millions of miles during the month. He is nearer at the present opposition than he has been for some years past (though not so near as he will be next time) and his surface will doubtless be carefully scrutinized.

Jupiter is morning star in Taurus, rising about 3 A. M. Venus is slowly overtaking him, but they will not be in conjunction till next month.

Saturn is in Aquarius and rises about midnight.

Uranus is in opposition on the 24th. He is very far south, being in R. A. 18 h. 10 m., dec. 23 deg. 41 m., about 3½ deg. south of the fourth magnitude star μ Sagittarii.

Neptune is in conjunction with the sun on the 30th and is invisible.

THE MOON.

New moon occurs at 1 A. M. on the 3d, first quarter at 8 A. M. on the 10th, full moon at 1 A. M. on the 17th, and last quarter at 3 P. M. on the 24th.

The moon is nearest us on the 13th and farthest away on the 25th. She is in conjunction with Jupiter and Mercury on the 1st, Mars on the 13th, Saturn on the 22d, Venus on the 28th, and Jupiter again on the 29th. The conjunction with Saturn is close.

At 10 P. M. on the 21st the sun reaches his greatest northern declination, and enters the sign of Cancer, an event described by the almanacs with the conventional phrase "Summer commences."

Cambridge, May 9, 1905.

ELECTRICITY AND BREAD.

The power of the electric current to decompose certain substances in a singular way has led to an important development of electro-chemistry. In this connection experiments have recently been made in Paris, seeking an improvement in bread making.

Laboring under the mistaken impression that the whiteness of wheat bread determines its quality—that the whiter the bread the better—the Parisian public has for years been growing more and more exacting on this score, and therefore the fineness of grain flour has been gradually approaching a limit. The public has, as a consequence, received a less nutritive food, it being a known fact that the core of the wheat grain, which is the chief constituent of bread, while producing the whitest flour, at the same time contains the smallest amount of albumen and is thus least nutritious.

There has recently been raised the hope of obtaining a whiter bread by aid of electricity, for which purpose the flour was brought in contact with electrified air, whose ozone possesses efficacious bleaching properties. A report to the Academy of Sciences at Paris on the result of an experiment with flour treated in both the ordinary way and by electricity, under similar conditions, explains that the flour subjected to electric influence was much whiter in color, but that its taste and odor were far inferior to those of flour treated by the ordinary method. The amount of phosphorus was the same in both, but the quantities of fatty and acid substances varied largely. Thus, in flour treated by electricity the fatty substances proved rancid, glutinous, and of a less yellowish color, and instead of retaining their usual aromatic, yellow state, became oxidized and partly converted into white sebacic acid, which could be dissolved in alcohol. The glutinous substances were discolored and changed.

The bread made from this flour was whiter than usual, but of inferior taste, and the experiment serves to demonstrate that electric treatment, while successfully turning flour whiter, injures it.

The number of persons employed in the United Kingdom in mines underground in 1904 was 681,683, against 676,746 in 1903; and the numbers above ground were 165,870 and 165,320 respectively.

SCIENCE NOTES.

A rubber film glove, the feature of which is antiseptic qualities, has been devised for surgeons. The idea consists of immersing the hands in a weak solution of gutta-percha in benzine or acetone, or applying the solution to the skin of the patient. The purpose of the film is to seal the surfaces of either the hands or skin with an insoluble, impervious, and practically imperceptible pellicle, which will not allow the secretions of the skin to escape, and will not admit blood, pus, or secretions into the crevices of the skin. Such a protective measure for surgeons is preferable to working with rubber gloves, inasmuch as the sense of touch or pliability of the skin is not impaired in any way, as is the case when detachable gloves are used.

A report has been presented to the French Academy of Sciences by M. J. Violle "on the action of hail cannons." In this report is given for the first time some trustworthy information covering a wide area and for an extended period, thereby supplying conclusive evidence as to the utility of this means of avoiding or mitigating damage in the vineyards from hailstorms. M. Violle's report refers to the district of Beaujolais, where there are established twenty-eight societies for dispersing in this manner the hailstorms common to that region. Comparing the losses suffered in the period 1900 to 1904, since the introduction of the cannon, with those of the preceding ten years, from 1891 to 1900, the evidence strongly supports the view that the cannon firing is protective. It has been frequently noticed, M. Violle remarks, that both lightning and thunder are suppressed within the zone where cannon are used, although they may be raging just outside the area.

Some discoveries of valuable archæological interest have been made in the tombs of Luxor by Mr. Theodore M. Davis, of Newport, R. I., who has been annually wintering in Egypt for many years. Mr. Davis has become an enthusiastic Egyptologist, and has carried out a number of excavations. During his latest investigations in February last, he unearthed in the Valley of the Tombs of the Kings in Luxor the tomb of a daughter of Amenhotep III. and of the father and mother of his wife Queen Thy. The mummies of the father and mother had been carefully unrolled in the search for jewels and gold in ancient times, but nothing had been discovered. The tomb contained coffins covered with gold leaf, carved and gilded chairs, alabaster Canopic jars, religious symbols of fine quality, a large roll of papyrus, and a complete chariot with wheels, pole, and neck yokes. The body of this chariot was covered with gold leaf. A special interest is attached to the last named, as it is the only complete chariot that has yet been discovered. It has been removed to the Cairo Museum.

A discovery of great archæological interest has been made in the district of Umtali in Central Africa during some recent exploration. Extensive ruins of what apparently were buildings of some antiquity have been revealed. One of the most interesting objects unearthed is a structure shaped like a cairn, and unique in the history of the country since the establishment of white rule. It is twelve feet long and about the same width, with a small curious construction at one end. Notable features of the cairn are that each side—excepting one, which has been displaced by the growth of a large tree—bears traces of skilled handiwork. The material, which strangely enough differs in character, is dressed and faced throughout in artistic style. One side is composed entirely of quartz, while the others consist of soapstone and gneiss respectively. Whether the structure covers the remains of some distinguished ancient, or merely symbolizes some important event in early times, remains to be seen. The whole of the ruins, and particularly the cairn, are being carefully examined by an expert, in the hope that they may furnish a clew, if not the key, to the mystery of the ruins at Great Zimbabwe.

The Secretary of the Treasury has instructed the collectors of customs that the astronomical instruments exported from this country for use by various astronomical expeditions for observing the coming eclipse are to be readmitted free of duty. The order was the result of a long correspondence between the director of the Lick Observatory in California and the Secretary of the Treasury. W. W. Campbell, director of the Lick Observatory, contended that the astronomical instruments which will be used for observing the eclipse should be readmitted into this country free of duty. Nearly all were manufactured abroad. Secretary Shaw has ruled that although the articles would ordinarily be subject to duty the interests of science demand that the law be suspended. Among the articles to which the ruling applies are telescopes, mirrors, prisms, lenses, clocks, tents, photographic materials and all manner of tools. A number of educational institutions, including Harvard, Princeton, and the University of Indiana, and also the United States Naval Observatory will contribute equipment for the three expeditions. The Lick Observatory will take general charge of the expedition.

A New Incandescent Lamp.

A new incandescent lamp with a zirconium filament is announced in Germany. Prof. Wedding, the well-known physicist, recently presented a lamp of this kind to the Electro-technical Society of Cologne. The details of the process are as follows: To obtain the filament he submits oxides of zirconium and magnesium at a high temperature to the action of hydrogen, which gives an alloy of a more or less constant composition. This body is then pulverized, and by adding a cellulose solution it is transformed into a plastic and homogeneous mass. It is from this mass that the filaments are drawn. The latter are carbonized in an atmosphere which is free from all traces of oxygen, and then present a metallic appearance. It is said that one pound of zirconium will furnish 50,000 filaments. The new lamp is to be placed on the market at the price of $0.37. Under regular working, the zirconium filament consumes a current of 2 watts per candle-power, which is less than for the usual carbon filament. The zirconium lamps are made at present to run with a current of 37 volts, and three of them can be conveniently placed in series across the usual 110-volt circuit. Another type uses 44 volts, and five lamps are connected upon a 220-volt circuit. To obtain a high candle-power lamp they place several filaments in the same bulb and the lamp is then connected directly upon a 110-volt circuit. Experiments which have been made with the lamp show that it has a life of 700 to 1,000 hours.

ELECTRIC MAIL AUTOMOBILES.

The post office department of Paris is now using several electric mail wagons which are designed to transport the mail matter in larger quantities and at a greater speed. These now run within the city limits, and distribute the mail between the main post office and the different branch offices which lie throughout the city. Our engraving shows one of these new automobiles, which have been specially built for the purpose by Mildé & Co., one of the leading electrical houses of the city. The new car has the advantage of running at a considerably higher speed and at the same time carries a larger quantity of mail matter—nearly half as much again as the horse vans which were formerly used exclusively for this purpose. These latter are still in use, but it is expected that they will be eventually replaced by the electric van. The latter contains about 45 cubic feet of available space in the interior for the mail matter. The automobile chassis which has been designed for the purpose carries the electric motor, which is built in compact form and entirely inclosed, in the center of the car. The differential device is contained in the same case with the motor. Chain driving is employed from a sprocket on each end of the differential shaft to a large sprocket mounted on each wheel. On the chassis is mounted a box body of considerable size which contains the accumulator cases in the lower part and above this the remainder of the space is used for the mail matter. Access is given to both compartments by a double door in the rear. The accumulator cells are contained in a single box, which can be easily slid out and replaced by a new one. The driver's seat, along with the steering wheel and the controller for the motor circuits, is placed high in the front.

ONE OF THE ELECTRIC AUTOMOBILE MAIL WAGONS IN USE IN PARIS.

ELECTRIC TRUCK WITH MOTORS IN WHEELS TRANSPORTING UNITED STATES MAIL.

It was decided to construct fifteen electric automobiles of the above pattern and put them in regular operation within the city limits in order to give them a good trial and especially to compare them with the horse vans, both as regards economy and speed of running. The new automobiles commenced the regular service about the first of November last, under the direction of M. Duboys, who is the chief of the mail transportation department. Since then the cars have been running very successfully, and all are in accord that they are a great improvement over the old system. Some 15 miles an hour is adopted as the highest speed which can be safely used within the city, but the motors can drive the cars at least as high as 25 miles an hour. Owing to the increased speed over the former system, the mail can be collected from the different post offices at a later hour and in like manner the mail can be distributed sooner, so that the schedule of collecting and closing the mails can be changed some thirty minutes in either direction, and this is a great point in favor of the new system. The increased capacity is another advantage which is appreciated by the post office department. A charging station for the accumulators used on the cars has been installed in the main post office building. The sets of batteries are double, so that while one case of cells is being used on a car, the second is being charged at the station. When the car arrives with an exhausted battery, the latter is at once replaced by a fresh one, without any loss of time. The batteries last for half-a-day's run, and the cars come in for charging twice a day, about noon and at night. The weight of the new cars is given as follows: The automobile proper, including the chassis, body, and mechanism, represents 2,220 pounds, while the accumulators weigh 1,320 pounds. The load of mail matter is 1,430 pounds, and two attendants 310 pounds, which makes somewhat over 2½ tons in all.

Automobiles for the transportation of mail matter are being experimented with by several of the leading governments, and gasoline mail cars are now in use in Berlin, Vienna, and in some of the rural districts of England. On the Isle of Man letters can be posted on a 'bus that travels across the island and carries the mails. The French government is the first to make use of electric automobiles for this purpose, despite the fact that machines of this type are now used so extensively for commercial purposes in this country, where they were first adopted for such service and where they are rapidly being perfected for it. That our own government does not take steps to improve its mail transportation facilities shows how unprogressive it is. Recently a large publishing house in New York, which has a government mail clerk constantly on duty for weighing and dispatching its mails, tried the experiment of making use of a novel electric truck driven by all four wheels, a picture of which is seen on this page. This truck carried a four-ton load of mail bags a distance of two and one-half miles and returned empty—thus covering a distance of five miles—in 58 minutes running time. It cut in half the time taken by horse-drawn vehicles, while the cost for current at six cents per kilowatt was about one cent per ton-mile of load carried. The truck itself weighed about four tons, hence including this weight, eight tons were moved at a cost for electricity of only half of one cent per ton-mile. This compares favorably with a gasoline truck, while there is not nearly so much wear and tear on the mechanism, or so many parts to get out of order.

The novel feature of the electric truck illustrated is not so much the motors in the wheels as the manner in which they drive the latter. The armature shaft is placed horizontally within the wheel, parallel to its plane; and a bevel pinion on each end of the motor shaft meshes with a bevel gear ring attached to the wheel. There are two rings facing each other; one pinion meshes with one of these rings, while the other meshes with the opposite ring. The thrust of one pinion against its ring is balanced by that of the other pinion against its ring. As these two forces are equal and opposite, they form a couple, the result of which is to relieve the armature bearings of nearly all pressure and thus reduce friction to a minimum. So great is this reduction of friction, because of the forces that produce rotation of the wheel acting equally on opposite sides of the bearings, that careful tests have shown an efficiency of transmission of 99 per cent up to 16 per cent overload. When it is remembered that the efficiency of a well-cut spur gear is only 85 to 90 per cent, and that in most modern electric trucks a double reduction is employed, it can readily be seen that there is a saving of about 25 per cent in transmission losses alone by employing the "couple gear" with single speed reduction. That the total efficiency of the vehicle is increased, also, by using four separate motors instead of two seems to be demonstrated by a 30 per cent decrease in current consumption when compared with an ordinary truck of like size.

The life of the battery and motors is greatly lengthened, also because they are never overloaded to any serious extent. The Exide battery on the present truck has been cleaned but once in the fifteen months the vehicle has been in service, and during which time it has covered something like four thousand miles.

So successful has been the manufacture of military rifles at the factory established in Quebec by Sir Charles Ross, that it is now proposed that Canada shall make her own cannon. The purpose in establishing the rifle factory in Quebec was to make the Dominion independent of English manufacturers, who, in the event of the interruption of communication, might be unable to supply rifles for the Canadian troops as rapidly as desired. The results have been entirely satisfactory. Now that the Canadian artillery is to be enlarged and re-armed with a more modern gun, it is held by military experts that the new ordnance should be made in the Dominion.

THE GRAPHIC CHRONOMETER.

BY EMILE GUARINI.

As its name indicates, the graphic chronometer, a recent invention of Dr. A. Jaquet, is employed for the graphic registration of time. It consists, in principle, of a watch having an anchor escapement of fine workmanship, the oscillations of which are, through the intermedium of a special arrangement, communicated to a registering lever. The time is registered by intervals of 0.2 of a second; but, by simply pressing a lever, it is possible to obtain the registration in entire seconds. The precise moment at which the chronometer starts to register is so sharply marked that it is possible even with a speed of 8 inches per fifth of a second, easily to determine the moment of starting within about four one-thousandths of a second.

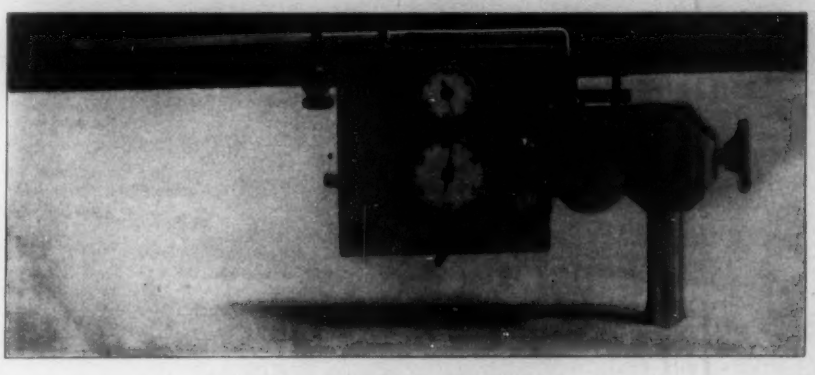
The graphic chronometer carries, in addition, two dials and two hands, one of which indicates the seconds and the other the minutes. Upon pressing a lever, it is possible to instantly bring the two hands back to zero.

Owing to two terminals with which the apparatus is provided, it can be placed in an electric circuit and thus made to graphically register, for example, the precise moment at which a race is started. It is possible to stop or start the instrument instantaneously by means of a lever placed at the lower part of the chronometer. For cases in which the arrangement of a place would cause an electric signal to be preferred as a register of the time, the instrument has been provided with a contact that permits of affecting also an indirect registration of the time.

A control screw in front serves also for regulating the vibrations of the registering lever. The instrument is constructed with a view to being used with vertical registering drums. If, however, it is desired to effect the registration upon a horizontal drum, it suffices to lighten by means of a thumbscrew a pressure spring, which, bearing against the back part of the registering lever, serves to counterbalance the weight of the latter in a horizontal position.

As regards the accuracy of the registration of the time, numerous experiments made with several different instruments have demonstrated that the amount of probable error varies between 0.0002 and 0.0006 of a second. The control of the absolute variation is effected by observation, for several hours, of the time indicated by the hands and a comparison with a good chronometer. Such possibility of the observer's making the control of himself constitutes, along with its great accuracy, one of the principal advantages of the apparatus, which, inclusive of its case, weighs a little over five pounds.

Its exceedingly compact form renders it particularly well adapted for clinical operations in which the instruments often have to be carried from one room to another, and in which an endeavor is made to avoid complicated installations.



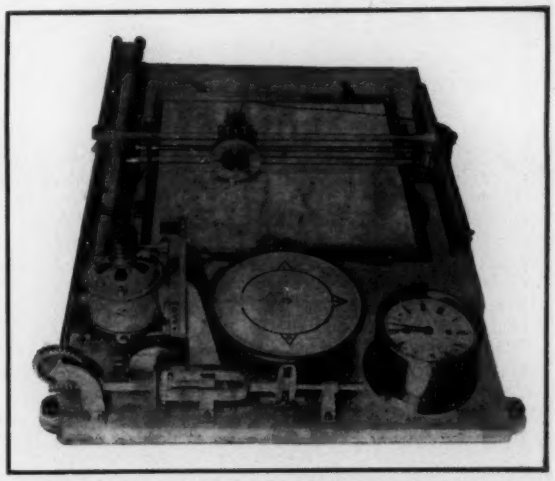
THE JAQUET GRAPHIC CHRONOMETER.

ELECTRIC DEAD RECKONER USED ON "VALHALLA" IN THE OCEAN RACE.

BY THE ENGLISH CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

Every navigator is fully cognizant of the importance attached to "dead reckoning," when no other means of locating his position can be followed, and special interest attaches to the automatic dead reckoner, herewith described, which is being used on the yacht "Valhalla" in the ocean race. For the purpose of facilitating dead reckoning and to enable it to be carried out with unerring exactitude with all possibility of errors eliminated, this ingenious electric apparatus has been introduced by Messrs. Siemens Brothers & Co., London. With this instrument all chances of error are obviated, and the "course and distance" made since the last known "position left" can be taken out by inspection at any moment.

The prominent feature of the appliance is that it makes all corrections for variation, deviation, and leeway. All that is necessary to determine the "course and distance" made, is to scale the "distance" between two points on the diagram with a properly divided parallel ruler, and then slide the ruler over the faint compass card printed on the diagram, and read off the "course." The rate at which the ship has been traveling at any moment can at once be read off the diagram, and the latter when filed away constitutes an actual record of the speed of the ship, and the course she was on, at every moment of time during which the "dead reckoner" was in use. The instrument comprises two essential parts, the transmitter, fixed on the poop, and the recorder, placed in the chart-room, the two being connected by a small electric cable about half an inch in diameter.



A View of the Recorder with Motor, Pelorus and Clock in the Foreground; the Time-Printing Wheel is Shown Over the Paper.

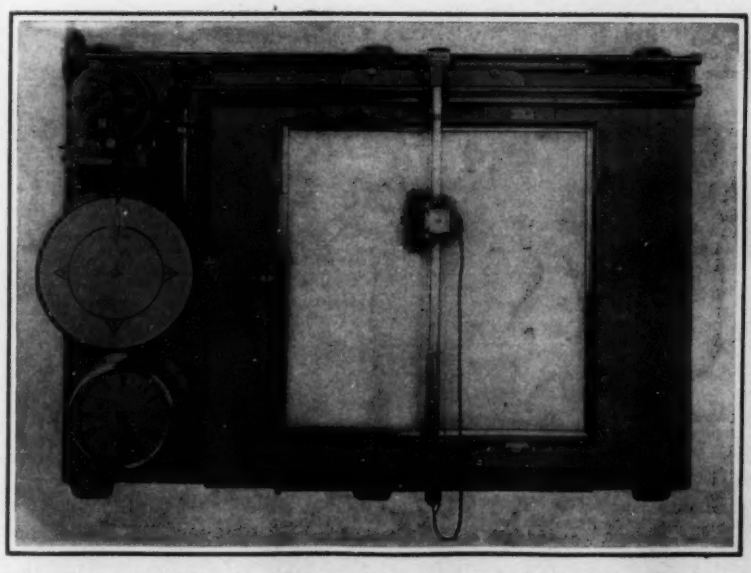
As will be seen from the accompanying illustration, the transmitter is carried on a pillar similar to a ship's compass. From the after end of the transmitter box projects a shaft terminating in an eye, to which the rotator is connected by the usual log line. This shaft carries a worm, which gears into a worm-wheel driving one half of a hunting switch, the other portion of the hunting switch being driven through suitable gearing by a small three-phase synchronous motor. The action of the mechanism is as follows: As the portion of the hunting switch driven by the rotator is revolved, it makes a series of contacts with the portion of the hunting switch driven by the motor. Directly the first contact is made, the motor starts, and by revolving the other portion of the hunting switch breaks this contact, and so comes to rest. If, however, the rotator continues to revolve, the motor will continue to run at a speed directly proportional to the speed of the rotator.

The recorder is mounted on a frame about 40 inches in length by 30 inches in width, on which frame are carried two screw spindles at right angles to each other, one of which is termed the north spindle and the other the east spindle. The north spindle is carried by a nut in which the east spindle works, and on a nut worked by the north spindle is fixed a time printing wheel. The north and east spindles are operatively connected with a "pelorus."

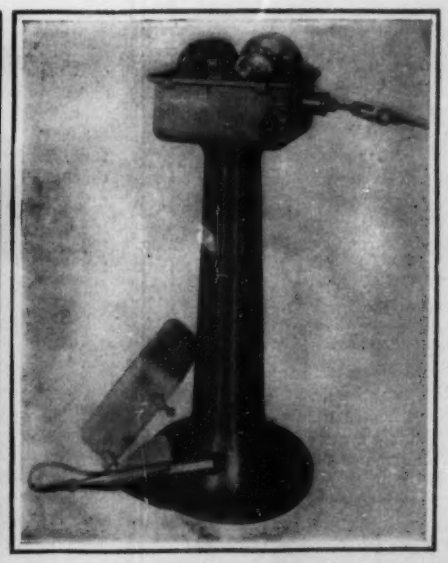
The mechanism controlling the pelorus is driven by a motor synchronized with the motor on the transmitter. By this arrangement, therefore, the travel of the timewheel is directly proportional to the distance traversed by the ship, quite independently of the direction in which the timewheel travels.

Consequently, as the direction of travel of the timewheel is controlled by the position of the pelorus relatively to the index, the line traced by the timewheel is, in length, directly proportional to the speed of the ship, and its direction is that indicated by the pelorus, namely, the course.

The timewheel is a circular brass wheel about four inches in diameter, having on its periphery numerals from I. to XII. representing hours, each hour being divided into quarters. Normally, this wheel is held away from the paper by a spring, but every 15 minutes an electric current is transmitted by a clock, which forms part of the apparatus, to an electro-magnet. This causes the wheel to press against the paper and the time as shown by the clock is recorded thereon. The wheel has a ratchet wheel fast with it, with 48 teeth, engaging a pawl. As soon therefore as the magnet has depressed the wheel to print, the spring withdraws it, and the pawl turns the wheel one forty-eighth of a revolution, ready for the next impression. The printing wheel is inked by a spool, against which it bears when at rest. The course is indicated by a series of dots printed by the timewheel. At every fourth dot the hour is also printed. By this means it is possible to obtain a more accurate result



Plan View of the Recorder, Showing the Rectangularly Disposed Spindles, One of Which Carries a Time-Printing Wheel by Which a Record of the Ship's Course is Plotted on the Paper.



The Transmitter Which is Operated by a Log-Line and is Electrically Connected With the Recorder in the Chart-Room.

ELECTRIC DEAD RECKONER IN USE ON YACHT "VALHALLA."

The Atchison, Topeka, and Santa Fé Railway Company is laying some portions of its road with rails weighing 101 pounds a yard. These rails have a foot 6 inches broad, and it is thought this may render the interposition of steel plates between rail and sleeper entirely unnecessary. The fish plates used with these rails are constructed so as to embrace the foot closely. The practice of this line is to place the nuts that secure the bolts of the fish-plates alternately inside and outside the rail.

than is attainable with a pen or pencil for tracing the course. The "course and distance" are reckoned between the first and last dot, and therefore a continuous line is unnecessary.

The clock attached to the instrument has an eight-day movement, and at every 15 minutes sends an impulse of electricity to the electro-magnet controlling the timewheel. It has to be set to "ship's time" at noon every day.

In steamships, where it is the custom to calculate the distance run from the revolutions of the propeller, the transmitter can be driven from the propeller shaft instead of by a rotator. A mark is made on one of the disks driven by the motor on the recorder. By counting the revolutions of this disk in a predetermined number of seconds (43 seconds in the present case) the speed in miles per hour at which the ship is moving can be ascertained at any moment.

The operation of the "dead reckoner" is quite simple. In the first place, the navigator throws the rotator overboard and connects it to the transmitter, fixes a sheet of paper in the frame holder, and slides it into position for action. The clock is then set going, and set "ship's time." The timewheel is also made to agree with the clock. The nuts of the north and east spindles are released and the timewheel placed in the starting position. The transmitter is set in motion by the turning of the key. This switches on the current, and clutches the rotator to the hunting switch.

To obtain the dead reckoning, it is first of all necessary to note the ship's head by compass. The pelorus is then set to this course. To make any correction for deviation, the pelorus is moved in the direction indicated on the instrument according as to whether the deviation is easterly or westerly.

For the purpose of taking out "course" and "distance made," the first dot (i. e. "position left") on diagram is connected to the last dot (i. e. "position in") by a line. The length of this line is measured on the scale, and the result is "the distance." By carrying this line by means of the parallel ruler to the compass card on the diagram, the course is obtained. To plot this result on the card from "position left" on chart, lay off "course" (magnetic). Then one leg of dividers is placed on the side scale of the chart at about "mid lat." and half the "distance" toward north is measured. Then the other leg of the dividers is placed in the point thus reached, and the first leg extended toward south to a point equal to half the "distance" from central point. The dividers then show total "distance." By placing one point of dividers on "position left" on chart, and the other point on "course" line, the "position in" is gained. Similarly, "difference of latitude" and "departure" can be ascertained.

HISTORY AND PRESENT STATUS OF THE PANAMA CANAL.

In tracing the history of the construction of the present Panama Canal we must go back to the year 1879, when an international congress met in Paris and recommended the building of a sea-level canal from Colon on the Atlantic to Panama on the Pacific. Although many members of the congress considered that a canal with locks was the most advisable type to build, the influence of M. de Lesseps prevailed, and a sea-level route was adopted. It was estimated that such a canal could be completed in twelve years, at a cost, including interest on capital, of $240,000,000. Work was begun in 1881, and at the outset the funds of the company were called upon heavily for the vast amount of plant that had to be purchased and placed along the line of the canal, and in providing the necessary shelter and conveniences for fifteen thousand laborers.

Work was no sooner commenced than troubles began. Climatic and topographical difficulties began to make themselves felt. For 25 miles the route of the canal followed the river Chagres, which in the rainy season is subjected to enormous freshets, and inadequate provision had been made for controlling these floods. As the excavation of the 8-mile cut through the divide proceeded, it was found that the ground was of an unstable character, and disastrous slides occurred, filling the cut as fast as it was excavated. Then the first opening of the surface soil along the route induced an appalling amount of sickness, and gradually the conviction forced itself upon the company that the task of building a sea-level canal was beyond their powers, being for them, at least, both physically and financially impossible. The company abandoned the scheme for a sea-level canal, and adopted a less expensive plan, which called for summit elevation and the provision of locks. But the change was made too late, and in 1889, after $156,400,000 had been expended, a receiver was appointed. The commission which was appointed to examine the company's affairs found that there had been an enormous amount of mismanagement and misappropriation of money; but they stated that the vast amount of machinery on hand, the engineering data procured, and the labor actually done on excavation and embankment, were worth to any new company at least $90,000,000. A further extension of time was received from Colombia, carrying the date of completion to 1904, and a still later concession extended the date to the year 1910.

In the autumn of 1894, a new company with a cash capital of $13,000,000 was formed to complete the canal. On coming into possession, they very wisely determined to make a most thorough engineering examination of the problem, and asked for the appointment of a technical commission composed of eminent engineers of different nationalities, whose experience in engineering work of this kind gave them special qualification for passing upon the surveys and plans, which were being made upon a most elaborate scale by the engineers of the new company. This commission presented a unanimous report in December, 1898, which, considering the standing and experience of the members, was considered to be one of the most representative and authoritative documents of the kind ever drawn up.

The international commission found that the work on the canal with locks, as outlined below, was at that time two-fifths completed, and that it would cost $87,000,000, or with twenty per cent for contingencies $102,400,000, to complete the work, the time required being estimated at from eight to ten years. The route of the canal, as approved in the amended plans of the commission, is about the same as that which will be followed by the canal, under whatever plans it may finally be completed. Its total length is 49 miles. The plan recommended by the commission has a summit level of 68 feet. A canal with two other summit levels, one at 96¾ feet, and the other of 32¾ feet, was considered, but the 68-foot level was chosen. In these plans the Chagres River was controlled by constructing two large dams, one at Alhajuela in the upper Chagres, about 9 1-3 miles above the canal, and the other at Bohio, at the end of the sea-level length of the canal at the Atlantic side. The Alhajuela dam was to serve as a source of power and of water supply for the summit level, and the Bohio dam, 1,286 feet in length, was intended to create an artificial lake to extend 13½ miles from Bohio to Obispo, with the channel of the canal dredged in the bed of the lake. The Bohio dam was intended to serve the double purpose of containing and controlling the flood waters of the Chagres, and reducing the amount of excavation necessary for the canal.

The route of the canal as thus located, and probably to be ultimately followed, is as follows: Commencing at Colon on the Atlantic, the first section, 15 miles in length, is tidal up to the site for the proposed locks at Bohio, by which vessels would be admitted to the lake formed by the Bohio dam. Of this tide-level stretch of the canal, the first 12 miles are navigable, the depth varying from 16 to 29.5 feet. It has been excavated to the original width, and a portion of it has been dredged to the depth of 29.5 feet originally determined upon. After passing the locks, the canal channel, according to the commission's plan, would have extended for 13½ miles along the bed of the lake to Obispo. Here another lift would have carried vessels to the summit level, 5 miles in length, with an elevation of 68 feet above mean sea level. Descent to the Pacific was to have been made by locks at Paraiso, Pedro Miguel, and at Miraflores, where vessels would reach tide level on the Pacific.

In the few years following the publication of the report of the international commission, the question of the advisability of the United States building an isthmian canal connecting the two oceans was fully realized, and public interest was greatly stimulated when it was understood that the French people were seriously considering the completion of the Panama canal. At that time it was popularly supposed that if the United States government undertook the construction of a canal, it would build it on the Nicaragua route, and there was a disposition to push the matter through as a government enterprise with all the speed that the nation's resources could guarantee. At the same time, the reports as to the feasibility of the Nicaragua canal which were made about this time by the government engineers, were distinctly unfavorable, and the confidence of the public in the possibility of building the Nicaragua canal for the sum of money estimated, and within the time specified, began to be rudely shaken. At the same time, the new Panama Canal Company, realizing that the construction of another canal at Nicaragua would seriously imperil the financial success of their own canal, strongly urged the American people to consider the superior advantages of the Panama to the Nicaragua route. From the very first the Scientific American took a decided stand in favor of Panama; for a careful consideration of the two schemes satisfied this journal that, judged both from the standpoint of feasibility and cost of construction, and convenience and safety of operation, the Panama route was greatly superior.

The mere statement of the comparative elements of importance in the two canals shows at once the superior advantages of the Panama route for an isthmian canal. The total length of the Panama canal is less than 50 miles, whereas the length of Nicaragua canal is 186 miles. In the Nicaragua canal there would have been 50 miles of curvature, with a total of 2,339 degrees; whereas at Panama the total length of curvature is only 23 miles, and the total number of degrees 771; while as for the time occupied in transit, a 400-foot ship would take 11¼ hours to pass through the Panama canal, as against 33 hours to pass from ocean to ocean by way of Nicaragua.

The Isthmian Canal Commission appointed by the President to investigate the whole question, after a careful investigation of both routes by its own parties of engineers and a careful study of the records and plans of the two companies, strongly recommended the Panama route. They estimated that the work already done at Panama, the Panama Railroad, the maps, drawings, etc., and the working plant, were worth to the United States not more than $40,000,000. Without going at any length into the history of the legislation in Congress, and the negotiations with the Panama Canal Company, and with the Colombian government, it is sufficient to say that the canal was purchased for the sum named, and the Colombian government received $10,000,000 for the purchase of a strip of land extending five miles on each side of the route of the canal from ocean to ocean. A commission was appointed to take hold of the project, undertake the government of the canal zone, make a start in the preliminary work of sanitation, and prosecute a thorough engineering survey, upon which it would be possible to determine the final plans for the completion of the great work.

It was soon discovered that the composition of the commission was somewhat cumbersome, and not calculated to give the best results in a work of this magnitude, and accordingly President Roosevelt abolished the commission and formed a new one which, it is believed, will prove to be thoroughly adequate to the carrying through of this stupendous undertaking. The new chairman of the commission, Mr. Theodore P. Shonts, who succeeded Rear Admiral Walker, is head also of the First Department, which is concerned with the fiscal affairs of the commission and the purchase and delivery of all material and supplies. The head of the Second Department, Charles E. Magoon, is governor of the canal zone, and in addition to the administration and enforcement of law, will have in charge the important work of sanitation. He is to reside on the isthmus, and devote his entire time to the service. The head of the Third Department is the chief engineer, John F. Wallace, who is to reside on the isthmus, have charge of the actual work of construction and of the practical operation of the railroad, with the special view of its utilization in the construction of the canal. The other members of the commission are Rear Admiral Endicott, U. S. N., Brig.-Gen. Hains, U. S. A., Col. Ernst, Corps of Engineers, U. S. A., and Benjamin M. Harrod. The chairman receives a salary of $30,000 a year, the chief engineer $25,000 a year, the governor $17,500 a year, and the other commissioners $7,500 a year each. William H. Burr and William Barclay Parsons are attached to the present organization as consulting engineers, and one leading civil engineer from England, France, and Germany will also act in an advisory capacity.

The results of the elaborate surveys, and the limited amount of construction that has been carried on under the present and preceding commission, have placed the chief engineer in a position to outline in a preliminary report the probable best type and size of canal to build at the isthmus. He estimates that a canal 150 feet in width at the bottom, and providing a minimum depth of water of 35 feet, could be built with a 60-foot summit level, with locks, for $178,000,000, and that it could be completed in from seven to eight years. A canal with a 30-foot level would cost $194,000,000, and could be built in from eight to ten years; while a sea-level canal would cost $230,000,000, and could probably be completed, or at least open for use, in ten years, and certainly in twelve years' time. These estimates are based upon the time and expense of cutting through the mountain divide; and the chief engineer is satisfied, from the experience that has already been had in excavating the Culebra cut, that it would be possible to take out material at 50 cents per cubic yard. He states that a mere perfunctory management of the work might increase this cost to 60 cents or more, whereas with efficient management and the use of the best machinery, the cost might be reduced to 40 cents per yard.

The further investigation that has been made of the site of the proposed Bohio dam, shows that there is a deep gorge or depression in the natural rock at this point, which would render it necessary to carry the core wall of the dam down to a depth of at least 150 feet below sea level. Mr. Wallace, therefore, prefers in any case, whether a sea-level canal or one with locks be built, to place the dam for the control of the river Chagres flood water at Gamboa, where a satisfactory foundation can be had and suitable locations are afforded for tunnel spillways. The surplus waters would be led from this dam either to the Pacific or to the Atlantic by means of tunnels through the divide or intervening hills. It is pointed out that the con-

struction of a dam at Gamboa has this advantage over the dam at Bohio, that whereas the destruction of the Bohio dam either by floods or by the act of man in time of war, would close the canal absolutely to traffic, the destruction of the Gamboa dam would cause only temporary interruption.

An Aerial Torpedo.

A test was recently made at Rockaway Point, Long Island, of a noval projectile invented by Mr. Joseph J. McIntyre, of Brooklyn, N. Y. As the title implies, the new projectile is of the explosive type, similar to a torpedo, but arranged to be driven through air instead of water. The torpedo, which resembles a huge rocket, carries a load of steel shrapnel and a high explosive which may be detonated by a time fuse or a percussion cap, scattering the shrapnel over a wide area. A brass cylinder contains at the lower end the lifting charge by which the projectile is fired into the air. At the upper end is the shrapnel and the high explosive. Several hundred steel shrapnel bullets are used. They are cast in strips and arranged about the inside of the casing, while in the center are three sticks of dynamite. The bullets and dynamite are all incased in plaster of Paris. A percussion cap at the upper end of the cylinder explodes the charge when the projectile strikes an object. The time fuse passes up through the center of the cylinder between the sticks of dynamite. The projectile is arranged to be fired like a rocket from a tripod which may be raised or lowered to different angles, and thus regulate the distance the torpedo will cover. This may also be governed by varying the quantity of lifting charge in the cylinder. In the Rockaway Point test a small charge was used, so that the action of the projectile could more easily be followed. The rockets in this case covered only a quarter of a mile, while with full charges they would have covered a mile or more. The tests were very successful, the rockets exploding when striking the ground, tearing large holes in the sand and scattering bullets over a large area. Several rockets were also fired out to sea, and exploded on striking the water. The third test, that of exploding a rocket in mid-air with a time fuse, was also successful. Mr. McIntyre has equipped his invention with a safety device which prevents premature explosion. This permits large quantities of the rockets to be transported in perfect safety.

World's Power Boat Record.

The official world's record for a power boat has been established by the "Napier II.," of Great Britain. This boat competed in several contests last year, but her performances were not considered satisfactory, although every indication of speed was manifested. It was therefore handed over again to the builders, Messrs. Yarrow & Co., of Poplar-on-Thames, and drastic alterations have been effected in the design of the hull, which is practically a new structure. Officially timed on the builder's recent trials the world's record for a knot was attained. Three runs were made over the measured mile, the first against the tide occupying 2 minutes 25 seconds, which is equal to 24.827 knots or 28.57 miles per hour; the second, with the tide, took 2 minutes 14 seconds, a speed of 26.86 knots or 30.93 miles per hour; the third, also with the tide, was timed to be 2 minutes 12 3-5 seconds, a speed of 27.149 knots or 31.26 miles per hour. The conditions were not propitious for fast speed, as the boat had to contend against half a gale of wind. The mean pace of the first and last runs, with and against the tide, is 25.988 knots or 29.925 miles an hour. For a 40-foot boat this is a meritorious performance. The previous best speed was attained by "Trefle-à-Quatre" at Juvisy, when 22.7 knots were recorded. "Napier II." is reconstructed upon original lines. It is perfectly flat-bottomed, with the sides of the bows perfectly perpendicular. The boat is propelled by two four-cylinder engines each developing 60 horse-power driving twin screws. At full speed the craft rides with about 6 feet of her bows out of the water, but makes very little wash.

The Current Supplement.

The current SUPPLEMENT, No. 1535, is opened with an excellent article on the car-ferry steamer "Detroit" of the Michigan Central Railroad. Rear-Admiral George W. Melville contributes a splendid review of the epochs in marine engineering. A technological article of interest is that on the manufacture of bronze colors. The artificial production of rubies is described and likewise illustrated. Steel-hardening metals have become of such importance, that Joseph Hyde Pratt's discussion of the subject will be followed with interest. Inventors will find of value an article on distance control by electric waves. Producer-Gas Power Plants is a subject which is fully discussed by A. Frederick Collins. Prof. Blondlot's puzzling discovery of the N-rays is made the subject of exhaustive inquiry by C. G. Abbot. The usual electrical notes, engineering notes, and trade notes and recipes are to be found in their accustomed places.

Automobile Notes.

In view of the recent lowering of the 1,000-mile nonstop track record 4 hours, 3 minutes, and 36 seconds by Charles Wridgeway on a Peerless car, further attempts at cutting the new time of 25 hours, 50 minutes, and 1 second will doubtless soon be made, and automobile enthusiasts will probably have a chance to witness several more such tests during the summer. Wridgeway covered 934 miles in 24 hours, or 123 miles more than the Packard machine, driven by Schmidt, made in the same time last summer. His average speed was about 39½ miles an hour. The car was run at an even rate following the indications of a speedometer. The only mishap was the breaking off of the exhaust pipe at the end of the twenty-second hour. The right-hand front wheel was changed four times because of the constant great strain upon it and its tire. The motor, however, did not stop during these or any of the other stops for supplies.

An overland long-distance endurance test of two Oldsmobile runabouts is now under way. The two machines started from New York on May 8 and are expected to arrive in Portland, Ore., on or before June 21, or within 42 days. The driver of the first machine to arrive is to receive a $1,000 prize. The runabouts will be the first machines to have crossed the continent from east to west. The drivers expect to attend the Good Roads Convention at the Lewis and Clark Exposition, to the president of which they are carrying messages. The machines reached Des Moines, Iowa, on May 20, after having encountered muddy and flooded roads in Illinois and Indiana and being pulled through Skunk River marshes with a block and tackle, during which passage they were completely submerged. They started from Omaha, Neb., on the 25th after spending one and one-half days there getting extra gasoline tanks fitted and preparing for the rest of the journey, during which they will cross Nebraska, Wyoming, and Oregon.

The opening of the track racing season in the vicinity of New York occurred on May 6 at Brighton Beach. The chief excitement of the day was furnished by the remodeled Ross steamer, which performed so successfully at Ormond last winter. Driven by Joe Nelson, this machine, which has been christened the "Lightning Bug," ran through the fence and was damaged considerably, though Nelson fortunately escaped injury. Besides a 5-mile exhibition performance by Walter Christie on his front-drive racer, there were no other specially interesting performances. The first meet at Morris Park—the new automobile race track—resulted in the cutting of one-fifth of a second off Barney Oldfield's old track record of a mile in 53 seconds. The new time was made by William Wallace's 90-horse-power Fiat. The new White steam racer did a mile in 53 seconds, and took second place in a 3-mile free-for-all race, which was won by Chevrolet on the Fiat in 2:51 4-5. The track was not in very good condition, it being too soft and not sufficiently banked at the sharp turn.

The first hill-climbing contest to be held this season took place at Springfield, Mass., recently, where a new Grout steam racer covered the 2,175 feet up a 9 to 12 per cent grade in 34 seconds. This new racer is fitted with two boilers and a 50-horse-power steam engine. The next best time for the hill was made by a 60-horse-power Napier car, which took 1 3-5 seconds longer to make the ascent. A Ford, a Reo, a Stevens-Duryea, and a large Columbia won first place in their respective classes, their times being in order, 57 3-5, 54 4-5, 47 2-5, and 41 1-5 seconds. A double opposed-cylinder Buick car made the climb with four passengers aboard in 50 1-5 seconds.

An automobile street cleaner is being placed on the market by an English firm of motor manufacturers. The vehicle is not only propelled by a gasoline motor, but is provided with four separate attachments, each of which is operated by the motor, and is designed for a special function. These comprise a rake to loosen caked mud upon the surface of the road, squeegees for use in wet weather, a revolving brush to clean up surface rubbish or dust, and a set of overlapping scrapers to complete the cleansing work. The revolving brush is so arranged that the dust and rubbish which it removes is deposited in a special receptacle, and no dust is raised in the air. This is a conspicuous advantage over the existing machine of this type, which can only be used at night time, when pedestrian traffic is practically nil, owing to the excessive contamination of the air by dust particles. The motor vehicle costs about $4,000, but working at an average speed of eight miles an hour, and being so varied in its operations, can carry out the work of some fifty men. These machines are to be introduced in English thoroughfares during the coming summer.

In making an electric furnace, according to Engineering Record, with limestone blocks, it is necessary to dry them in a stove or otherwise for 10 to 24 hours, as the least moisture will cause a block to crack when subjected to the heat of the arc.

Correspondence.

Why the Stone Ball Moves.

To the Editor of the SCIENTIFIC AMERICAN:

Concerning the spontaneously moving stone ball at Marion, Ohio, noticed in the SCIENTIFIC AMERICAN for April 15, assuming its description to be free from error, permit me to suggest that such a movement must be due to some artificial cause or to the axial rotation of the earth.

If to the latter, its direction should be somewhat to the east of south, its southerly motion being due to centrifugal action, while its easterly deflection should be the result of a "throw," due to the velocity of terrestrial rotation in that latitude, which should vary but little from 800 miles per hour; the actual direction of the rotation of the ball being the resultant of these, modified by friction.

Akron, N. Y., May 19, 1905. JULIUS PETERSON.

The Stone Ball Again.

To the Editor of the SCIENTIFIC AMERICAN:

We were very much interested in the moving ball described in your issue of April 15, and think there is another probable cause not given, at least we have not noticed it referred to, viz., the capillary attraction hypothesis; and assume that the ball does not fit the socket perfectly, leaving a space to be filled with water, frequently by rain and dew distilled at night, which would be drawn up by the force of capillary attraction between the cup and ball, and this film of water would be evaporated by the sun's rays on the south side first, and the ball drop to that side, causing the ball to move from north to south, just as we find taking place in the instance referred to.

Oshawa, Ont., May 23, 1905. J. W. PROVAN.

An Automobile for Market Gardeners.

To the Editor of the SCIENTIFIC AMERICAN:

The market gardeners and farmers of the country, and particularly the market gardeners, need an automobile for working the soil. To one who reads the papers devoted to agriculture regularly this will seem to be at first glance a ridiculous statement, because the farm papers, almost without exception, denounce the automobile. Nevertheless, the machine for working the soil is needed, and a sale can be made of the right kind of a machine in spite of prejudice. Let me specify some of the features that such a machine should have.

That it should be simple in construction is, of course, the first of all the requisites. It should then be small, so as to require but little space at the end of a furrow. It should be easily steered, and turn within its own length. The width of tread should be variable. The rims of the wheels should connect with the hubs by means of sheet-metal plates instead of spokes. The width of tire should be about five inches. The whole machine should weigh as little as possible consistent with strength. It should be geared to run at two speeds, if not three. The motor should be designed so that it could be disconnected from the wheels of the machine, and used for the numerous purposes for which motors are wanted on the farm, such as thrashing and pumping. The machine must be arranged to drag all kinds of farm implements, and to haul the crop to market. If it were able to do service as a carriage as well, so much the better.

In proof that such a machine can be sold in spite of prejudice, consider this one fact: Gardeners now plant many vegetables in rows three feet apart, that might better be planted a foot apart. The wide spaces are required because a horse must be used to cultivate the vegetables. I have heard of spaces two feet wide between rows being cultivated by a horse, but I never saw it done. A well-built machine could travel between rows a foot apart, or at worst fifteen inches apart, and that is to say that an automobile cultivator would just about double the truck crop that can be raised on an acre of ground.

When the late W. W. Huntley, of Silver Creek, N. Y., began making bran dusters to take flour out of bran, the millers laughed at him. They said to take out the flour would spoil the sale of the bran. But Huntley persuaded one, here and there, to try the machine, and he agreed to take the flour thus saved during a stated period as pay for the machine. That always sold the machine. In like manner place a well-designed automobile in the hands of a reputable truck-grower, and the machine will sell itself. Where is the manufacturer who will first occupy this field?

Northwood, N. Y., May 22, 1905. JOHN R. SPEARS.

The Crater of Kilauea.

A correspondent located at Hilo, Hawaii, informs us of two heavy earthquakes occurring there early in May, and of the great activity of Kilauea crater. Two fountains of lava were playing in the bottom of the crater pit, causing a large flow of lava, making an interesting sight for tourists.

THE GRUBB GUN-SIGHT.

A collimating telescopic gun-sight has been invented by Sir Howard Grubb, which departs so radically from the usual type of sight, that a brief description of its salient features may not be without interest.

As shown in Fig. 6 of the accompanying illustrations, the sight consists of a short metallic tube, the rear end of which is closed by a window of parallel plate glass, the lower portion of which is silvered on the inside, while the upper portion is left perfectly transparent. The front end of the tube is closed by a curved glass, the concave surface of which is coated with a chemically-deposited film, which is both semi-transparent and highly reflective. The curved glass, therefore, acts as a transmitter and a reflector of light. The tube is formed at the top into a hood containing a glass diaphragm covered with an opaque coating, on which is cut a cross.

no necessity for a back sight, which is a very important advantage in itself if the weapon is to be handled in a strained position.

That the virtual or ghost image of the cross is really formed at or near the plane of the object aimed at, is proved by the small photograph in the lower right-hand corner of Fig. 1. The photograph was obtained by placing the camera a few feet behind the sight, focusing on the framework of the sight, and exposing the plate. As shown in the picture, the sight body itself is quite indistinct, but the distant views of the dome and the cross are both quite clear, proving that this ghost image of the cross is practically in the plane of the distant dome. In looking through the sight, the object aimed at is seen as distinctly as with any open sight, except for the very slight loss of light occasioned by the semi-transparent film.

Much of the difficulty experienced by novices depends

respect it has an advantage over the ordinary telescopic sight, in which accuracy and constancy of adjustment are most essential.

In the accompanying illustrations, Figs. 1 and 2 show the Grubb sight adapted for use with a six-pounder naval mounting. The bracket for the sight is constructed so as to fit on the mounting after the removal of the ordinary tangent sight. The appliance is mounted on the top of a radial rack securely held by and capable of sliding in a socket formed in the sight bracket. A worm wheel and pinion gear serve to elevate the sight rack. Deflection of the sight is arranged for, and consists in training the sight around a center by milled head and screw in the usual manner.

Fig. 3 shows the instrument applied to a bar sight for a twelve-pounder rapid-fire mounting. In this case the sight is carried above the ordinary back sight, and may be easily and quickly removed, held as it is by a

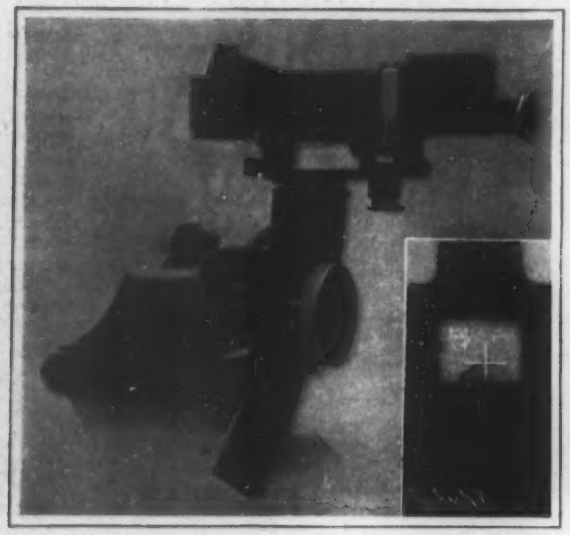


Photo. taken through a sight.

Fig. 1.—The Sight on a Six-Pounder Mounting.

Fig. 2.—The Grubb Sight Applied to a Six-Pounder.

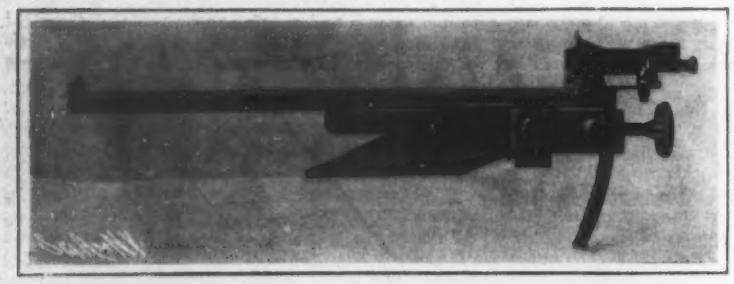


Fig. 3.—The Sight Applied to a Twelve-Pounder Rapid-Fire Mounting.

Fig. 4.—The Grubb Sight Applied to a British Service Weapon.

Fig. 5.—Grubb Sight on a Six-Inch Rapid-Fire Gun.

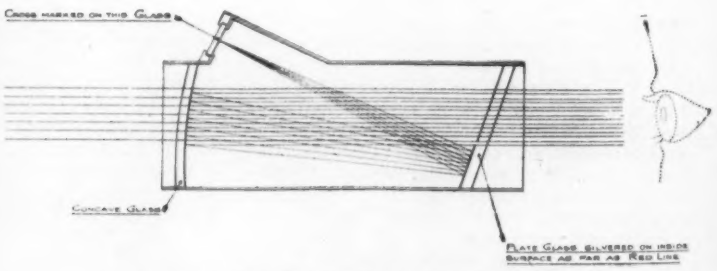


Fig. 6.—Optical Principle of the Grubb Sight.

A NEW GUN-SIGHT WHICH DOES AWAY WITH THE ORDINARY FORESIGHT.

The manner in which this optical system works is well shown in Fig. 6. The rays emanating from the target are transmitted both through the front and back windows without refraction, and enter the eye exactly as if there were no sight at all. On the other hand, the rays which enter the eye to form the image of the cross diverge, and are reflected from the silvered portion of the back window onto the concave surface of the front window which, being coated with a reflective film, diverts the rays in question through the transparent upper part of the back window, and thus to the observer's eye. Because of the peculiar curvature of the front window, the rays of the cross are parallelized after reflection, so that they enter the eye as if they had emanated from a large cross on the distant object itself. The cross is, therefore, optically superimposed on the target.

Since the observer's eye is absolutely fixed, there is upon the impossibility of seeing the ordinary foresight of the rifle simultaneously with the target. In the case of the instrument we have just described, the foresight can be completely discarded.

Although this sight is not a telescopic sight in the true sense of the word, it can be made to magnify, if desired, and that without some of the disadvantages of ordinary magnification. Just as it is possible to focus both object and cross on a photographic plate, so also is it possible to focus both in a field glass and a telescope. The larger patterns of the sight (used for field and naval guns and guns of position) are all supplied with attachments for monoculars and binoculars. The telescope, however, in this case is used simply as a means of magnification of both object and cross, and any error of adjustment or looseness in the lenses in no way affects the accuracy of the sighting, because it affects both the object and the cross equally. In this

bayonet joint arrangement and a small spring catch.

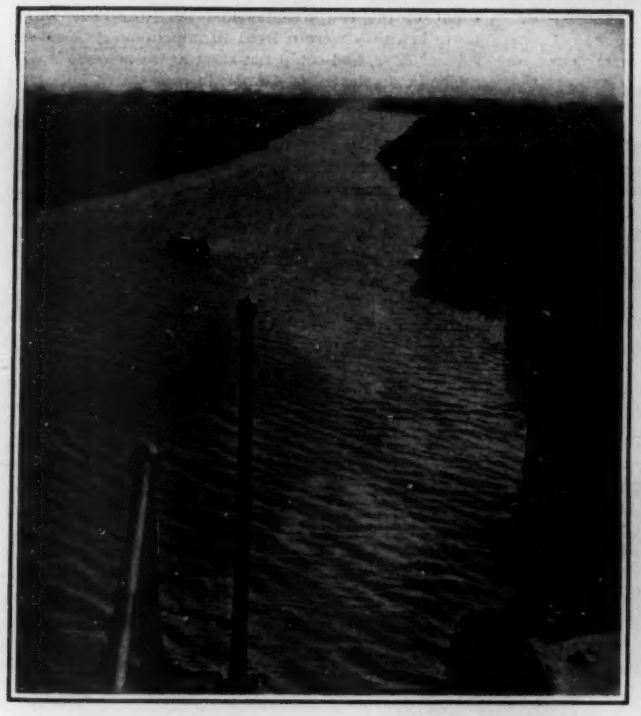
Fig. 4 shows the sight fitted to a British 0.303 service rifle. The sight does not interfere at all with the ordinary sights, because it is mounted to slide on the face of an arc on the left-hand side of the rifle. The top of this arch is notched, and the notches are cut to correspond with given ranges engraved on the arc. A spring catch holds the sight at any of the notches, adjustment of range being effected by sliding the sight along the arc.

In Fig. 5 the Grubb sight is shown fitted in conjunction with a bar sight of a six-inch rapid-fire mounting, the Grubb sight being carried on an extension of the ordinary sight bar, so that it is to the rear and slightly above the ordinary back sight.

It is calculated that the mass of the solar corona is not necessarily greater than 25,000,000 tons.

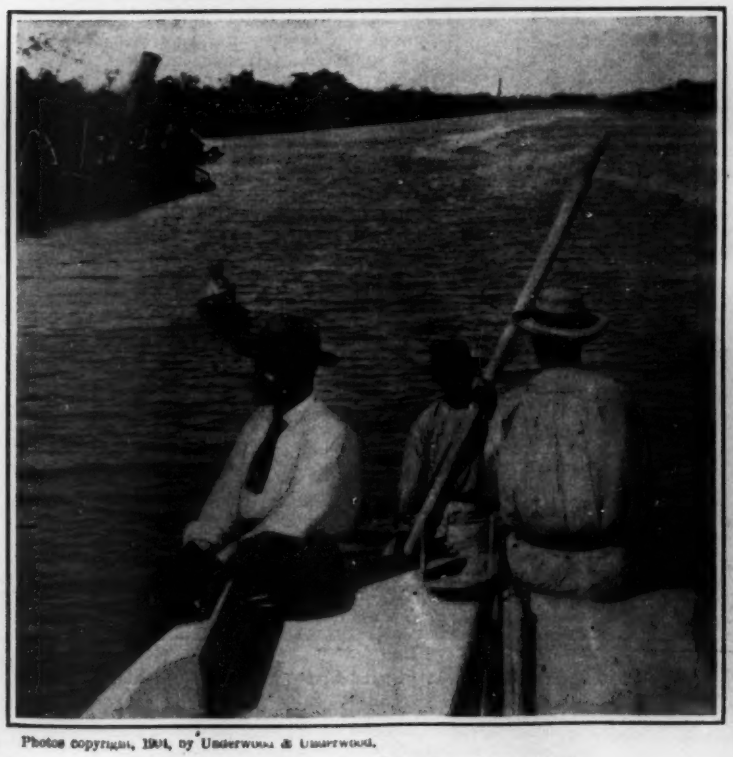
An Uncompleted Cut, Showing French Excavating Plant Still Available.

Rock Excavation in the Culebra Cut.



Partially Excavated Portion of the Canal at Atlantic End.

Old Spanish Fort and Islands at the Pacific Entrance.



Photos copyright, 1904, by Underwood & Underwood.

By Launch up the Excavated Portion of the Canal.

Part of the Old Company's Plant.

HISTORY AND PRESENT STATUS OF THE PANAMA CANAL.—[See page 442.]

THE ALGIERS-TOULON MOTOR-BOAT RACE.

BY THE PARIS CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

The Algiers-Toulon race was organized in the first place by the Matin, one of the leading Paris journals. Then followed the cup offered by M. Charley, the Paris representative of the Mercedes automobile company. The French Minister of the Marine offered a prize, and also lent his aid to the event, and allotted a torpedo destroyer to accompany each of the racers. This encouraged the constructors to build a type of especially heavy racing boat, adapted to run in the open sea. The racers varied from 30 to 80 feet in length, and the motors ranged from 35 to 200 horse-power. The smallest boat was the Italian racer "Fiat," which measured 30 feet in length, while the largest, the "Quand-Meme," owned by the Duc Decazes, was 73.46 feet long, 9.84-foot beam and 1.05-foot draft, and fitted with two motors of 100 horse-power and driving twin screws. The "Camille," a Paris-built racer of 60 horse-power and 43 feet length, was piloted by Madame du Gast, the well-known sportswoman. The "Heracles II." was built of mahogany. It had a double hull, with tarred paper between the layers. The machinery was well protected by a liberal deck. The boat was 35 feet long, had a 60-horse-power motor, and carried a crew of seven. The hulls of the two Mercedes boats, besides those of the "Camille" and "Heracles II.," were built by the Pitre Company in Paris. The "Mercedes C. P." had a 45-foot steel hull and a 90-horse-power Mercedes motor. She carried a crew of six. The "Mercedes-Mercedes" was 60 feet long, and had two 90-horse-power Mercedes motors placed in line, one behind the other, and driving a single propeller. This boat was provided with a mast and smokestack and carried a crew of five. The "Malgré Tout" was 65 feet long, 11 feet beam, and had a 6-foot draft. Its weight was 14½ tons, 5 tons of which was due to a heavy cast-iron keel. It was rigged as a yawl, and carried 170 square yards of canvas. Both the 120-horse-power motor and the boat itself were built by M. Roche. The crew consisted of six men. The "Quand-Meme," as can be seen from the illustration, was the largest and handsomest boat of the lot. It weighed 15 tons, and had a draft of 4 feet. Two Beaudoin motors of 100 horse-power each drove twin screws. This boat had nine men on board. Despite the fact that she carried 700 gallons of gasoline, lack of fuel was one of the causes for her final abandonment.

The start took place from the port of Algiers at 6 o'clock in the morning, led off by the "Quand-Meme." Then, at intervals of a few minutes, came the "Mercedes C. P.," the "Mercedes-Mercedes," the "Fiat," the "Camille," the "Malgré Tout," and the "Heracles II." The time was taken upon one of the large torpedo destroyers, which lay at the mouth of the port, as the boats passed by at full speed. The line of boats was preceded by "La Hire" and followed by the "Mousqueton," while the battleships "Kleber" and "Desaix" accompanied the fleet on the passage. A few of the motor boats, such as the "Heracles II." and the "Malgré Tout," hoisted their sails at the start, while the rest ran with the motor alone. They soon disappeared in the distance.

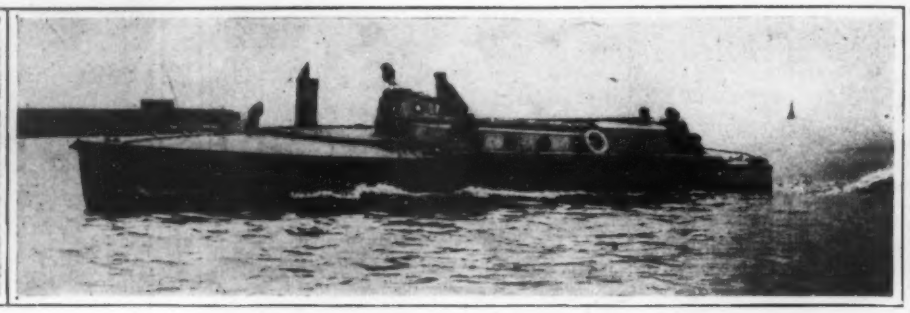
Six of the boats succeeded in arriving at Mahon in good order. First came the "Fiat" at 6:15 P. M., it having made the 195 nautical miles (224.79 statute miles) from Algiers to Mahon in a little over 12 hours, with an average speed of 16 knots (18.54 statute miles) an hour. Then followed the "Camille" at 10 o'clock, taking 16 hours for the trip. Not long after came the "Mercedes C. P." at 10:43 (17 hours), then the "Mercedes-Mercedes" at 12:30 (18½ hours), and the "Quand-Meme" at 1:45 A. M. (20 hours). The "Malgré Tout" came into port towed by the "Carabine," while the "Heracles II." did not arrive until late in the morning, at 11 o'clock.

Thus the valiant little Italian boat, the "Fiat," carried off the honors of the first part of the course. It came into port accompanied by the destroyer "Arc," and after the latter had anchored, the "Fiat" made a brilliant run across the port at full speed, amid wild cheering from the assembled crowd. It had made the long trip of over 200 miles without the slightest accident, and had kept up a very regular speed. Preparations were then made for leaving Mahon, and continuing the second part of the race to Toulon. But on account of the bad weather and the heavy sea which prevailed, they were obliged to remain in the port for several days, and could not start again before May 13.

The boats started at 4 A. M. in good order, but afterward the sea became rougher. The "Fiat" had to be taken on board "La Hire" when 45 miles out from Mahon, as it passed through the smaller waves and shipped water. Then some of the other boats were taken in tow, owing to different accidents. These were the "Mercedes C. P.," the "Heracles II.," the "Malgré Tout," and, later on, the "Mercedes-Mercedes." At 10 o'clock the breeze stiffened, but the "Camille" was making good headway, as was also the "Quand-Meme." At 5 P. M. the "Camille" had to be taken in tow. The weather had been comparatively good at the start, but toward 10 A. M. the barometer fell very fast, and toward evening a violent storm came on, which was one of the worst ever seen in that region. Under these conditions most of the boats were first taken in tow, and afterward abandoned, as they could not be hoisted into the destroyers in such a heavy sea. The "Mercedes C. P.," which had been running admirably, was later towed by the "Hallebarde," but the boat was swamped in the heavy sea, and the towline had to be cut. The "Camille," also under tow, broke away and was left at the mercy of the waves. It was only with great difficulty that the battleship "Kleber" was able to save Madame du Gast and the crew. The "Malgré Tout," "Heracles II.," and "Mercedes-Mercedes" met with a similar fate, while the "Quand-Meme" was kept afloat until 5 P. M. on the 14th, when her crew were obliged to abandon her and be taken aboard the "Arbalete." Thus all the boats were lost with the exception of the

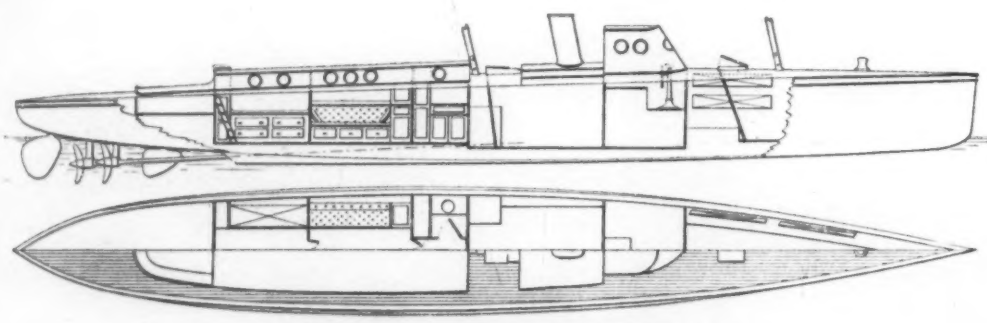
The 30-Foot Long, 5½-Foot Beam, 25-30 H.-P. "Fiat."

This boat weighs only 880 lbs. Although the smallest in the race, it made the best time, going half way across the Mediterranean Sea (225 miles) in 12 hours at an average speed of 16 knots (18.54 miles) an hour.

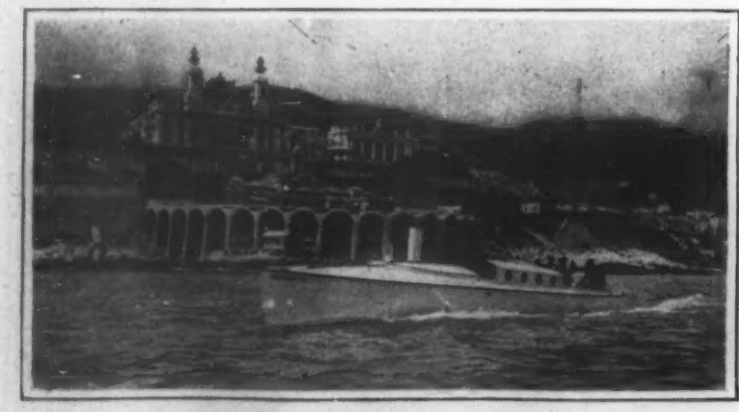


Madame du Gast Piloting the 43-Foot, 60 H.-P. "Camille."

The "Camille" reached Port Mahon second in 16 hours, or at an average speed of 12 1-5 knots (14 miles) an hour.

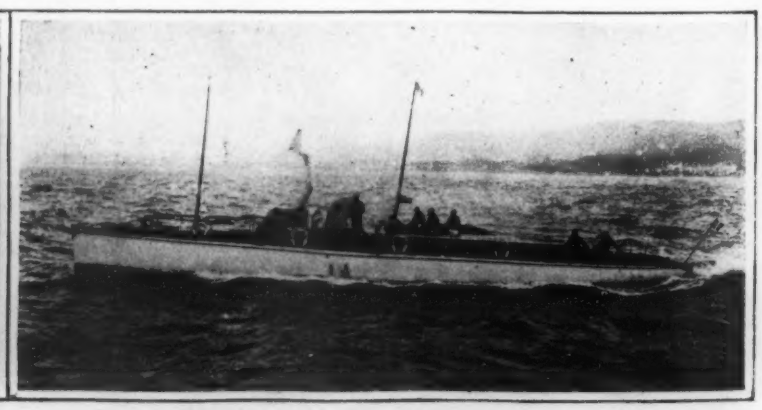


Longitudinal Section and Plan of the "Quand-Meme."



The 45-Foot, 80 H.-P. "Mercedes C. P."

This boat arrived third in 17 hours, thus making an average speed of 11¼ knots (13¾ miles) an hour.



The 75-Foot, 200 H.-P. "Quand-Meme" of the Duc Decazes.

Although she did not make as fast time as the other boats in the first half of the race, the "Quand-Meme" proved to be the most seaworthy in the second half, as her crew stayed on her 36 hours, while the other boats were abandoned a whole day before.

THE PRINCIPAL COMPETITORS IN THE DISASTROUS ALGIERS-TOULON MOTOR-BOAT RACE.

"Fiat." Had it not been for the exceptionally heavy tempest, there is no doubt that they would have reached Toulon.

DO ANIMALS REASON?

BY NELSON R. BRIGGS.

There is much diversity of opinion on the question "Do animals reason?" even among scientists. But so long as scientists and doctors disagree, it is an open question as to how much more learned they are upon many subjects than the common, every-day man with equally as good reasoning powers, and neither with facts to prove his assertions other than reasoning powers.

I take great pleasure, however, in presenting to the readers of the SCIENTIFIC AMERICAN, that they may judge for themselves, an illustration to this article of a photograph of a cat opening a door, and thus gaining an entrance to the house. I took this photograph on March 17 last, about three P. M., after first watching the cat open the door two or three times, that I might the better judge of the best location for my camera, and, as I had no shutter to my lens, I was obliged to make the exposure by uncapping and capping the lens.

The photograph speaks for itself. The cat is of the yellow type, of good size, and belongs to Lanson Wiswall, a farmer living about three miles from Ballston Spa, N. Y. Mr. Wiswall says the cat was not taught to do this trick, if such it may be called; and how it came to understand or reason out that, even though the door was fastened with the old-fashioned thumb-latch, it could gain admittance to the house at will, by simply jumping up and grasping hold of the handle of the latch with one paw, and striking the thumb-piece with the other until the door swung open, is as much a mystery to him as it is to strangers who have witnessed the act.

Now, does this act not show reasoning powers on the part of the cat, when, finding that it could not push the door open with its nose or paw, it looks about and discovers that there is a latch, by climbing up to and striking which with its paw, it can open the door?

My experience and study of animals of the higher order of intelligence has induced me to maintain that most, if not all, animals do possess reasoning powers, and the above act simply adds to and strengthens my belief.

I am not disposed to agree with Mr. Burroughs, who says: "Such traits in animals are simply physical."

But there is, however, considerable philosophy in Mr. Deacon's statements. He says: "Whenever we find an animal able to learn by its own individual experience, we have the same right to predicate mind as existing in such an animal, that we have to predicate it as existing in any human being other than ourselves. Huxley observes that 'a race of dumb men deprived of all communication with those who could speak, would be little indeed removed from the beast.'"

Thus, it would appear that the mind of man in childhood, or in savagery, is not by any means so superior to that of the higher animals as is claimed by some. Such animals are speechless by reason of an anatomical accident, and not from an absence of ideas or ignorance of words.

AN UNUSUAL INCIDENT OF CABLE WORK.

BY MAJOR EDGAR RUSSELL.

The submarine cable between Valdez, on Prince William Sound, Alaska, and Sitka, Alaska, was suddenly interrupted on November 6, 1904. The cable had been laid about a month before by the cable ship "Burnside," operating under direction of officers of United States Signal Corps, and had been in perfect working order up to the time of its interruption. Tests from the Sitka office located the trouble about ten miles out from Sitka. The cable ship proceeded to Sitka to make repairs on January 24, 1905. While heaving in the cable toward the fault, the dynamometer began to show considerable strain. At first it was thought the cable was caught under a rock, and the ship was accordingly maneuvered to loosen it. Heaving in was slowly continued, when the carcass of a whale appeared, with a loop of the cable fastened around the lower jaw, as shown in the photograph. The loop was twisted, as well, thus securely holding the whale. The carcass was badly decayed, and the stench made the task of loosening the cable from the jaw most trying. During its struggles the huge animal had badly twisted and torn the cable in its vicinity, making several breaks in the conductor, thus interrupting communication. The steel armor wires, with the exception of three, were broken at the twist of the loop, and had the cable not possessed great tensile strength (20,000 pounds) it would undoubtedly have been broken. A splice was soon made, and communication between Valdez and Sitka restored.

One theory as to this peculiar accident is that the whale in feeding along the bottom was swimming

A CAT THAT HAS LEARNED HOW TO OPEN A DOOR.

slowly with jaws open. The cable being suspended on irregularites of the bottom, it came across the whale's open mouth, and the animal in its endeavor to disengage itself threw a loop in the cable. The whale was about fifty feet long. The depth at the place where it was found is sixty-five fathoms.

One other case of interruption of a cable by a whale is on record. This occurred in the Red Sea many years ago, and was caused by a loop of the cable being caught around the whale's tail. This, and interesting cases of interruption of cables by fishes, are described in SCIENTIFIC AMERICAN SUPPLEMENT, Nos. 46, 113, and 114.

The Misunderstood Inventor.

BY W. D. GRAVES.

By a very large class, one who attempts anything new, with a view to getting material returns therefor, is looked upon with good-natured contempt, on account of the large percentage of failures in that line; yet, in most born mechanics there is an ingrowing desire to create some new thing or process, or to improve some old one. If he fails, he is laughed at; if he succeeds, he is pronounced "lucky."

For a mechanic, however, there is little chance other than this, for any very material advancement.

Invention is one of the very few fields in which one can give a man his money's worth and still make more than wages for himself; and, as in other fields, the only road to success is through repeated trials.

Worth is often difficult to ascertain, an unknown quantity, generally only to be judged by what one can get; but, whether it is known or not, there always is a *real* value; and, in buying and selling, one must buy for less or sell for more, or both, in order to make a profit above actual living wages for work done.

An inventor is, in a worldly sense, a creator, and may justly claim as recompense the value of his invention to others (though he rarely gets anything like that) without consideration of its cost to him; which cost is, by the way, generally much more than the average observer is likely to guess.

The cost of an invention consists not only of the actual time and money spent on that one device, but may justly include a portion of the expenditure on the many previous and unsuccessful ones, the bleaching bones of which ornament, or deface, the walls of the workshop of every inventor who has attained any measure of success.

A business man, conversing with the writer a few days since, commented on the remarkable sale of a recent invention, and observed that the inventor was probably making a fortune as the result of a happy thought. The writer happened to know that the inventor in question was not making any fortune, because he had not the business ability nor the capital necessary to make the device the success which it is, and that he sold his patent for a sum far under a fortune.

The writer well remembers, too, the Monday morning when he came to the shop with the "happy thought" shining through his countenance.

The invention, while a "happy thought" indeed, was not instantaneous, but was the outcome of many years of thought and practical work along those lines which lead to successful invention; and, after the thought came, there were many days of work, study, and experiment before the thing was in practicable form.

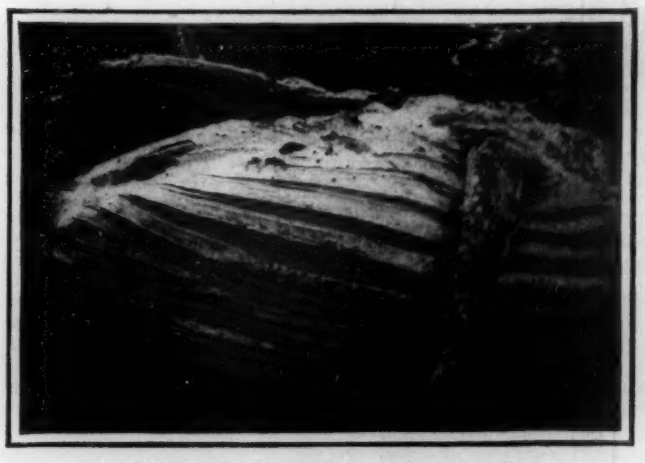
At the time of making this invention he was a man whose hair was well sprinkled with gray, a thorough mechanic in his line, and the owner of half a dozen patents on really practical devices, none of which had paid expenses.

Say who will, that he knows, yet no man knows or can do more than to guess whether an invention will or will not sell; and the inventor knows least of all, till he tries.

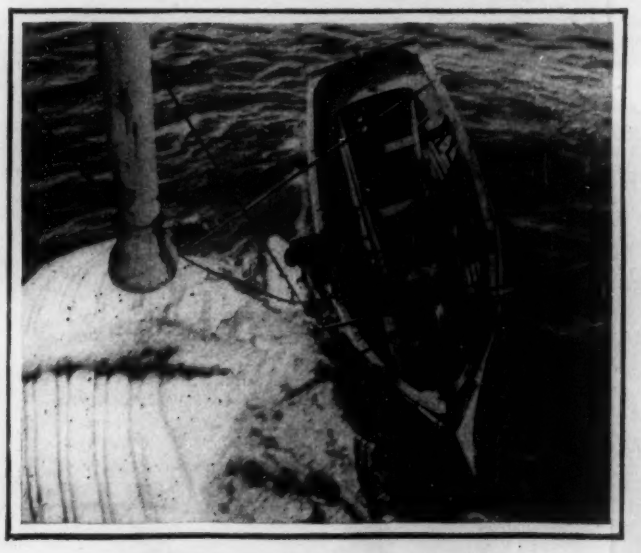
In reckoning the cost, then, is it not just to reckon those years of work and study which he devoted to unsalable inventions and which led up to the salable one?

Many writers of note, and of technical education, hold that, given the demand, a machine or mechanical device may be very readily worked out by fixed mechanical rules; and, while this is to a certain extent true, it is often the case that a man with the mechanical "knack" makes a short cut which leaves the calculator far behind, and the demand is often created by the device, or aroused to an extent which surprises the longest-headed prognosticators.

How often we see little things put on the market and sold in phenomenal quantities, for which we never dreamed of a demand till we saw them, but which we find absolutely essential to our comfort and wonder why we didn't think of them ourselves.



Whale Caught in Sitka-Valdez Submarine Cable.



Untangling the Whale from the Cable.

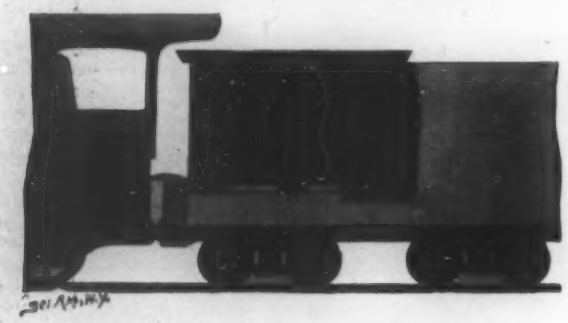
AN UNUSUAL INCIDENT OF CABLE WORK.

The sugar industry has made considerable progress in Japan of late. The extensive plantations of sugar cane in the island of Formosa are to be remarked in this connection and show the efforts which are being made toward home production. It is thus expected to diminish the imports from foreign countries. At present there are two large sugar refineries near Osaka and Tokio, which produced on an average 2,000 tons per month in 1903. The financial results are said to be very favorable, seeing that the cost of production is but $1 per picul (130 pounds). A third refinery is soon to be installed at Dairu in the island of Kyshu and it will suffice for the consumption in the south of Japan. The capital employed will be about $500,000. The works are favorably located near large coal mines.

Patent Department

TURRET COAL BIN FOR LOCOMOTIVE TENDERS.

A recent patent describes a new type of coal bin for locomotive tenders which offers the advantage of holding the coal always within easy reach of the cab, so that the necessity of dragging down the coal is avoided. The bin consists of a large drum provided with a central pivot pin which turns in a socket bearing in the floor of the tender. It is also supported by rollers traveling on tracks on the tender. The drum carries along its lower edge a peripheral rack which is connected by a train of gearing with a hand wheel. The latter may be operated to rotate the bin on its pivot to any desired position. The bin is divided by a central vertical partition into two compartments. Each compartment may be entered through double doors opening inwardly. These doors are cut away at the bottom, forming a triangular opening through which the coal may be shoveled out. A vertically swinging gate is provided for closing this opening when desired. When all the coal within easy reach of this opening has been shoveled out the doors of the bin may be opened to gain access to the rest of the coal. As soon as one compartment is emptied, the hand wheel is operated to turn the bin around until the other compartment is brought into convenient partition for shoveling out the coal. Our illustration shows the bin partly swung around. In the central position of the bin there are two doors which may be used in case of emergency. If, for example, an accident should occur which would prevent turning the bin, coal could be drawn from the filled compartment through one of these doors. The doors are arranged to open on opposite sides of the partition, so that no matter which compartment is filled it can be entered from the other compartment by one or the other of these doors. The inventor of this coal bin is Mr. C. C. Collette, 928 Florida Street, Springfield, Mo.



TURRET COAL BIN FOR LOCOMOTIVE TENDERS.

IMPROVED DUMPING CAR.

The accompanying engraving illustrates an improved dumping car invented by Mr. Herman Peiler, of Koloa, Kauai, Hawaii, Box 20. The car is so designed that it may be tilted to either side desired and at such an angle that the entire load will be dumped. As shown in the accompanying engraving the car comprises a bed mounted on wheels and a body portion resting on the bed. The side walls of the car body are hinged at their upper corners so that they can swing out to release the load when the car is dumped. Normally these sides are locked in closed position by means of hasps which engage eyes mounted on the main part of the car body. The arc-shaped pins which lock the hasps are attached to a rock shaft passing through the car body. The positions of the hasps on opposite sides of the car are such that when the shaft is rocked in one direction, one of the hasps will be unlocked, and when rocked in the other direction the other will be unlocked. Mounted on the bed under the ends of the car body, are rollers which, however, do not engage the body except when the latter is tilted. A pair of levers of special design are provided for tilting the car body, when the latter will roll sideways until arrested by pivot pins thereon engaging arms secured to the side sills of the car bed. Before tilting the car body the rock shaft should be operated to release the desired hasp so that the corresponding side wall will be free to swing out and permit dumping the load. After the load has been dumped the car body is attached with chains to the levers which are drawn back to return the parts to normal position. The car body is centered on the bed by means of socket pieces which slip over studs secured to the car bed, and in this position it is locked by pins which pass through the studs and into the body of the car.

IMPROVED DUMPING CAR.

Brief Notes Concerning Patents.

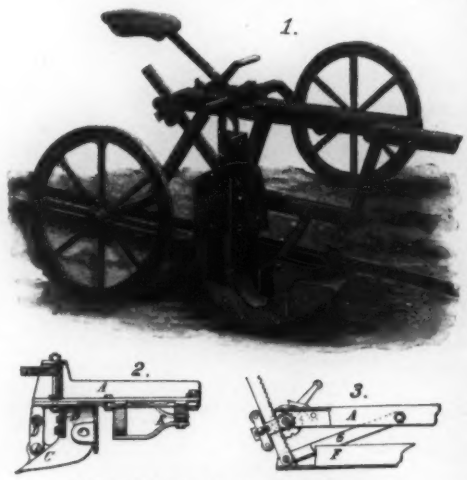
A so-called "improvement" in devices for preventing collisions, accidents, etc., by railway trains has recently been invented. It consists essentially in a folding framework, known as a "lazy-tongs," the rear end of which is connected to a locomotive in such a manner that by operating a lever the framework may be folded or extended, so that the forward end will extend a considerable distance ahead of the train. Trucks support the framework at intervals, and are secured to the pivotal points of the levers making up the framework. The forward truck is provided with a buffer-bar, springs being interposed between this bar and the truck frame. An electrical alarm sounds within the engine when the bar comes in contact with any resisting body. The impossibility of this device performing the objects of its inventor would be apparent if one considers for a moment the force of impact due to the momentum of so large and swiftly-moving a body as a railway train. Even if the buffer device were sufficiently long and afforded resistance to any appreciable effect in reducing the speed of the train, the inertia of the joints could not be overcome with the needed rapidity for their response to the collision, and as a consequence, the wreck would be materially increased by the number of members in the "lazy-tongs."

An infringement suit has been brought against the management of the Louisiana Purchase Exposition, involving the invention of the identification card, which was made use of in the shape of passes to the late show. The patent covering the identification card was originally granted to B. L. Behrendt, of Chicago, Ill., and is now controlled by the Fraternal Identification Company of America.

A new type of berth, the object of which is to overcome seasickness, is in course of experiment upon two of the steamships plying between Dover and Calais. The berth is the device of a London dentist. The apparatus comprises a swinging cot suspended in a steel framework by four cords passing through electric brakes, which automatically maintain the bunk in a horizontal position, no matter how much the vessel may roll. The berth is fitted with a water mattress and an electric fan.

AN IMPROVED DITCHING MACHINE.

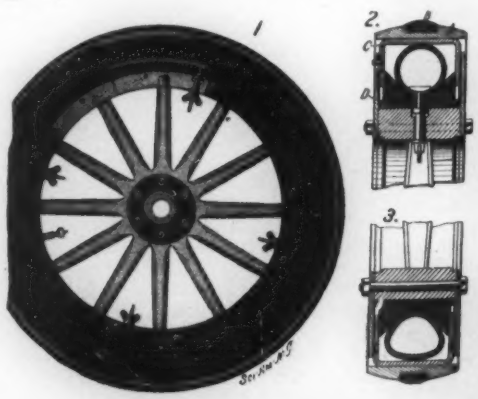
An economic and effective machine for making ditches for the purpose of under-draining land with tile, slate, etc., has been provided by the recent invention of Mr. Walter Umstead, of Jerseytown, Columbia County, Pa. The machine is arranged to be conveniently raised or lowered, so that the ditch may be carried to the desired depth by successive operations without undue strain on the team. The parts are so designed as to cut a straight, clean ditch, sweeping the dirt away from the edges. As shown in the accompanying engraving, the beam, *A*, is secured to the arched axle of the machine and carries the tongue at its forward end. This beam is made of channel iron, and at the rear end, between the side flanges, a pinion is mounted. The latter may be operated by a crank handle to raise or lower an inclined rack bar with which it is in engagement. The bar is held against the pinion by friction rollers mounted on a swinging yoke-piece, as illustrated. At its lower end the bar is hinged to a horizontal head bar, *F*, which carries a vertical standard against which the shank, *B*, of the plow is secured. Between the edge of this standard and the plow shank an L-shaped groove is formed into which a tongue on the clearing wing, *C*, is fitted. The wing thus has guided movement in a vertical direction. A coil spring, *D*, presses it down so as to hold it in engagement with the surface of the ground. The wing, *C*, is formed with a plate which curves over and in front of the plow shank so as to catch the soil that is turned up and guide it off to the side of the ditch. Directly in front of the plow are a pair of cutter plates, *E*, designed to cut the turf and any roots that may be encountered and to smooth off the sides of the ditch. It will be observed that the left-hand plate is considerably in advance of the other. In use the crank is turned to lower the plow and cutters to the required extent, while the clearing wing adjusts itself under pressure of the spring against the surface of the ground. It will be observed that the head bar, *F*, is connected by two links, *G*, to the beam, *A*, so that it will always lie horizontal no matter if swung up or down. The draft attachment is made close to the cutters, *E*, and the neck yoke is free to slide on the tongue so that it will adjust itself to different positions of the head bar. After the ditch has been cut the plow and cutters may be raised clear of the ground by operating the crank handle.



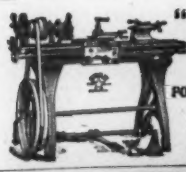
AN IMPROVED DITCHING MACHINE.

A PUNCTURE-PROOF TIRE.

A very interesting solution of the tire problem is offered by the recent invention of Mr. Thomas W. Ranson, Jr., of 135 North Perry Street, Cleveland, Ohio. In Mr. Ranson's vehicle wheel the tire is not placed on the outer periphery, but within a protecting rim of steel, so that the desired pneumatic cushion effect will be secured without exposing the rubber tube to the slightest danger of puncture, or to any great amount of wear. To furnish a certain degree of elasticity, and provide the requisite grip of the tire on the ground, a band of solid rubber is set into the steel rim. The steel rim is indicated at *A* in the engraving, and at *B* may be seen the solid rubber band. The rim, *A*, is attached to a steel ring, *C*, which is of inverted channel form, the side flanges projecting inward within a pair of face plates, *D*, bolted to the sides of the felly. Between these plates on the felly is a retaining ring of solid rubber, provided with a V-shaped outer periphery, in which the pneumatic tube is seated. The latter presses outward against the channel ring, *C*, but will give at the tread, permitting the ring, *C*, to slide within the plates, *D*, and producing the pneumatic cushion effect. The retainer and the tube are attached to the felly by means of a number of tire bolts. If, for any reason, the pneumatic tube should become deflated, the wheel could still be used by passing bolts through the holes in the channel ring just outside of the face plates, so that the ends of the bolts would rest on the edges of the face plates and hold the steel rim, *A*, concentric with the rest of the wheel. This, of course, sacrifices the elasticity of the tire to a large extent, but is of little consequence in cases of emergency. The construction of the tire is also advantageous for another reason, namely, that in guiding the vehicle around sharp corners, there is no probability of the tire being thrown off, as happens with many constructions now in use.



A PUNCTURE-PROOF TIRE.



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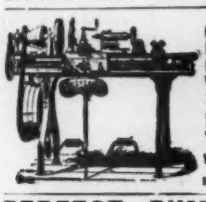

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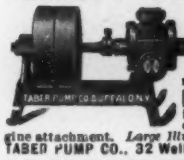

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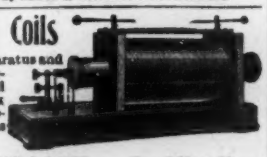

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RECENTLY PATENTED INVENTIONS.

Electrical Devices.

TROLLEY.—J. H. CLARK, Urichsville, Ohio. The object of this invention, which relates to improvements in trolleys for electric-railway systems, is to provide a harp and combined oil and bearing boxes for the trolley-spindle so constructed that the boxes can be readily reversed from one harp member to the other to compensate for wear, and when the bearings in the boxes are worn out new ones may be placed in the harp.

Of Interest to Farmers.

HEEL-SLIDE FOR PLOWS. — E. M. TOUTCHTONE, Valdosta, Ga. It is sought by this invention to provide a novel form of heel which can be readily applied to any of the ordinary forms of plows, now commonly used —such, for instance, as the "Avery," the "Georgia ratchet," and any other form of plow-stock that works without a heel. The construction is simple, and in operation on the roughest land will hold the plow steady and the work easier for both plowman and horse.

Of General Interest.

SAW GAGE AND JOINTER.—T. OLSEN, Manistee, Mich. The object of the inventor is to provide a device readily adjustable and easily handled. In operating upon the cleaner teeth the face plate is placed against the saw and the flanges engage on the top of the teeth, with the cleaner-tooth extended through a receiving slot. After filing one cleaner-tooth the device may be readily removed to the next. In top-jointing, flanges are placed against the blade of the saw and the file passed over tops of the teeth.

MEANS FOR ATTACHING BOILER-TUBES TO THE TUBE-SHEETS.—H. L. MCCULLOUGH, Cropsey, Ill. In this patent the invention pertains to steam-boilers; and the purpose is to provide a new and improved means for attaching the boiler-tubes to the heads of the tube-sheets and arranged to prevent leakage due to unequal contraction and expansion of the tubes and the tube-sheets.

T-BOLT.—G. R. LANG, Cincinnati, Ohio. It is customary to clamp work upon planers, boring-mills, and other machine-tools by means of bolts having heads passing into T-slots in the surface of the bed. When different size or class of work is substituted for one previously used, these bolts have to be changed, and hunting new ones consumes time and is a great waste. Also when bolts of proper length are not on hand new ones are forged and threads turned upon them to receive the nut to be used. By means of a removable head for the bolt, which can be used with any length of bolt and not to be renewed, the inventor does away with above delays and forging.

FILTER.—T. LINKE, New York, N. Y. The intention in this case is to provide a filtering-faucet of simple construction so arranged that either filtered or unfiltered water may be discharged from it, that may be conveniently manipulated by a handle at the top, that may be readily dismembered for repairing without discharging water, and which has a novel arrangement of stone-cleaners.

PERMUTATION LOCKING DEVICE FOR LOCKETS.—O. KATZENBERGER, San Antonio, Texas. This improvement refers to locking devices for lockets such as are usually worn suspended from the neck of a person, and more particularly to such as are adapted to contain a miniature likeness or other valued souvenir, and its object is to provide a permutation device having a hinged lid, which will be adapted to secure the lid closed until the correct combination is attained by proper manipulation of working parts of the device.

METAL JOINTING.—M. H. BIGSBY, Monmouth, Ill. The invention refers to improvement in means for jointing or securing two metallic members, the object being to provide a simple means for connecting two metal numbers together while in a cold condition, the invention being particularly adapted to cold-rolled steel or finished metal designed to be plated or polished.

Heating and Lighting.

MANTLE FOR GAS-BURNERS.—A. H. SASSMAN, New York, N. Y. A mantle is provided by this invention especially adapted for use in connection with gas-burners used for heating purposes. The mantle so surrounds the burner as to direct the heat from the burner in concentrated form in an upward direction and at the same time is so far removed from the burner that the flame from the burner will create a suction, drawing up air between the mantle and burner, which is heated and conducted upward with the actual heat from the flame of the burner.

Machines and Mechanical Devices.

ELEVATOR.—A. KARBER, St. Joseph, Mo. The invention has reference to an elevator in which the car is moved by means of screws or worms climbing on corresponding racks, by which arrangement it is practically impossible for the car to drop through the shaft upon the breakage of some part of the machinery. Electric current is taken to the elevator mechanism by a trolley, and let out therefrom through another and its arm or pole.

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MACHINES.—H. MANNING, 46 Grays Inn road, London, England. The mechanism is for lock-stitch sewing machines; and comprises a presser-foot for feeding, a lever comprising an open frame with cam-surfaces and at its upper end an arm carrying the foot, a shaft extending through the opening in the lever and carrying a cam-stud adapted to carry the lever's cam-surfaces a part of the shaft's revolution to move the lever in one direction to feed work, a spring secured at one end to the machine-frame and bearing at its other end on said lever to move it in the opposite direction when the stud is out of operative engagement with the lever. An adjustable stop consisting of a set-screw screwing through a lug on the machine frame is provided with a lock-nut, said lever having a padded projection for engaging the stop-screw.

CENTRIFUGAL APPARATUS FOR ELECTROLYTIC PURPOSES.—R. V. HEUSER, Erie, Pa. This apparatus is partly electrolytic and partly centrifugal, with the following advantages: Comparatively great output per unit of weight of apparatus employed and large percentage of product as compared with quantity of brine employed; greater current density at the cathode; use of mercury not required; process continuous and capable of carrying out without stopping apparatus from running; considerable labor saved; apparatus given comparatively large proportions and yet be under complete control of operator; anodes possess great durability; no colloidal member nor diaphragm is required.

LEMON-SQUEEZER.—P. MCGRATH, Hibbing, Minn. This lemon-squeezer is of that type in which a plunger is forced into a cup to press the lemon. The invention provides various improvements intended to facilitate the adjustment of the parts, and insure the efficiency of the squeezer. A prominent feature consisting of a plunger is so mounted as to permit of being rotated when the lemon has been squeezed, whereby to more effectively press the juice and pulp from the fruit.

Prime Movers and Their Accessories.

TURBINE.—L. E. TRUESDEL, Kershaw, S. C. The underlying objects of the present improvement are to more effectively distribute the pressure of the steam or other elastic fluid around the periphery of the rotor of the turbine and also to improve the devices for governing the turbine action. The invention relates particularly to an improvement in radial-flow turbines, and it is of the same general class as that forming the subject of a prior patent granted to Mr. Truesdel.

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LUBRICATING-BEARING FOR AXLE-JOURNALS.—T. V. MONROE and M. HALLINAN, Clinton, Iowa. The invention relates to an improvement in bearings for locomotive axle-journals, and has for its object the provision of a simple, cheap, and efficient device of the character mentioned and one which can be readily applied to the journal-boxes now in use. Oil and waste are placed within the upper cellar, and the waste projects through the open center of the bearing-plate against the axle journal. Waste is held in place and prevented from rolling by inturned flanges.

RAILROAD-SWITCH.—W. H. SAMMONS, North Bend, Ore. The object of this invention is to provide a three-way switch and means to be carried by a locomotive or street car for operating the switch therefrom. In order that the switch may be operated at will by an engineer or motorman, Mr. Sammons provides the front part of the locomotive or car in advance of its forward wheels with a rotatable shaft carrying switch-operating shoes. When necessary to operate the switches by hand switch-blocks are connected to a switch-stand by operating-rods.

Pertaining to Recreation.

CUE-TRIMMER.—A. B. LOW, Denver, Col. This invention refers to improvements in devices for removing old glue from and trimming or leveling the ends of billiard or like cues preparatory to placing tips thereon, an object being to provide a trimmer of simple construction that will readily adjust itself to cues of varying sizes.

BASE-BALL GAME APPARATUS.—J. E. DAUER, Summerville, S. C. In the present patent the invention relates to a base-ball-game apparatus having a multiple dial, read in connection with certain instructions, usually printed upon a slip. The game can be played by eighteen persons, representing two full sides, or it can be played by one person, using the men and operating them according to instructions on the slip.

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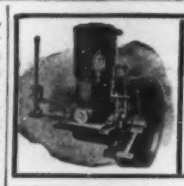

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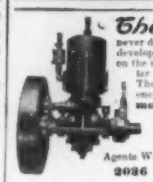

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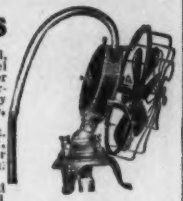

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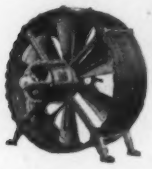

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(9644) M. G. A. asks: Please answer the following questions, and settle a dispute between parties of the physics class of high school of this city. Let a ray of light passing through a highly refractive body, from a point within approach the surface, making the angle of incidence greater than the critical angle. Does not one part of a wave front, emerging from the surface before the other part, pass into the air, and traveling at an increased velocity, swing around and enter the body again, the lower extremity meanwhile remaining below the surface? Can the ray properly be said to be reflected as if the surface were a perfect mirror, or to be reflected at all? Is not the left extremity of a wave front in the incident ray, the right extremity in the reflected ray, when the ray is reflected by a mirror? Is this so in the case of the so-called total internal reflection? If the answer to the first question is not in the affirmative, please give the reason why part of every wave front does not emerge from the said surface. If the first part of the third question is answered in the negative, please explain what actually does occur. A. If any portion of a wave front of light can pass from one medium into another, the whole of that wave front can pass, and refraction will result. Total reflection takes place when the angle of refraction becomes as great as 90 deg. Then no portion of the wave can pass into the rarer medium. All is turned back into the denser medium, as may be seen by the use of a right-angled prism, receiving the light perpendicularly upon one of its equal faces. The surface at which the total reflection takes place is a perfect mirror. No mirror can reflect more light. This can be seen in a glass of water, by holding it above the eye and looking up into the water obliquely from below. The upper surface shines as bright as silver perfectly polished. The sides of a wave system are reversed after total reflection as they are after any other reflection.

(9645) C. K. B. asks: What is the cause, or where do the prevailing westerly winds of the northern hemisphere originate? How does the rotation of the earth cause the deflection of the trade and anti-trade winds of the northern hemisphere? A. The general systems of the winds are due to the greater heat of the torrid zone. This produces the inflow of air from the cooler regions on either side of the hot region. The heated and lighter air is forced up by the flowing of the colder air under it, and it flows away to the north and south in the upper layers of the air. After this air is cooled it descends, and flows along toward the poles, only to return and again take part in the general circulation of the winds. The rotation of the earth on its axis causes great changes in direction of these currents, and we have northeast and southwest winds as more or less permanent winds in different parts of the northern hemisphere. This is but a rough and general statement of the winds, but may serve as a basis for fuller reading on the subject in the physical geographies. As the current of cooler air flows along over the smooth surface of the ocean in the torrid zone north of the equator, it is passing from a region where the velocity of rotation of the earth is less to a place where it is greater. This causes the wind to lag with reference to the earth under it, and to appear to come from a point farther to the east than it has really come. It thus becomes a northeast wind, and is the northeast trades. For a similar reason the returning currents of air over the ocean become southwest winds, or the anti-trade winds.

(9646) A. W. asks: 1. In calculating horse-power of an engine, has weight of piston any bearing on amount of horse-power? Why not? A. The weight of the piston of an engine has no influence on the horse-power excepting in so far as it affects the friction of an engine. This latter is very small. 2. Could a water motor on 10 pounds pressure maintain compressed air in cylinder at 25 pounds pressure, i.e., can water motor 10 pounds water pressure compress air to give 25 pounds pressure? A water motor acting on a pressure of 10 pounds per square inch could maintain compressed air in a cylinder at 25 pounds pressure per square inch, provided the area of the piston in the water cylinder were more than two and one-half times as great as the area of the piston in the air cylinder.

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(9647) O. S. asks: I have seen two different methods for reading, by attached vernier, 1-500 part of 1 inch, as follows: 1. To divide on the scale 1 inch in 20 1-20, and on the vernier 25 parts, which 25 parts equal on the scale 24½. 2. To divide on the scale 1 inch in 20 1-20, and on the vernier 25 parts, which 25 parts equal on the scale 19 1-20. I am a scientific instrument maker, and I have very much to do with verniers for reading 1-500 parts of 1 inch, so I ask you kindly to tell me which of these two methods is correct. A. If you wish a vernier reading to 1-500 of one inch, you should first divide each inch on your scale into 20 equal parts, and then, by means of the vernier, be able to divide each part into 25ths. There are two ways of doing this, either one of which is absolutely accurate. First. Make your vernier 24-20 of an inch long, and divide it into 25 equal parts. Each part will then equal 24-500 inch. Each main division of the scale itself equals 25-500. The difference one division on the scale and one division on the vernier, therefore, equals 1-500 of an inch, as required. Second. Make the vernier 26-20 of an inch long, and divide it into 25 equal parts. One division on the vernier then equals 26-500 inch, while one division on the scale equals 25-500. The difference between the two, therefore, is 1-500 of an inch, as before. These are the only current methods of making the vernier, provided each inch on the scale is divided into 20 equal parts. You can readily determine which of these two types of vernier will suit your purpose in any given case.

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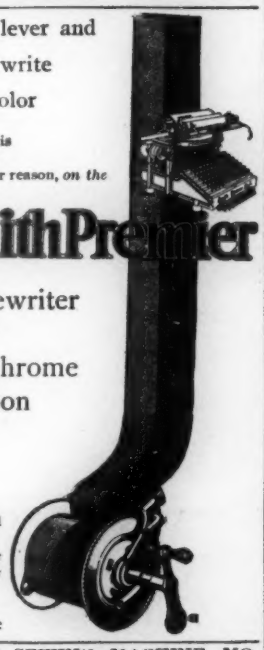

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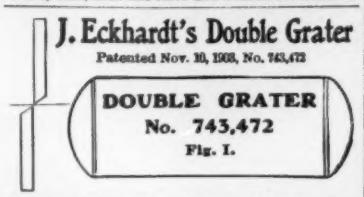

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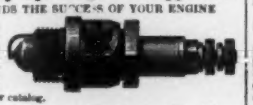

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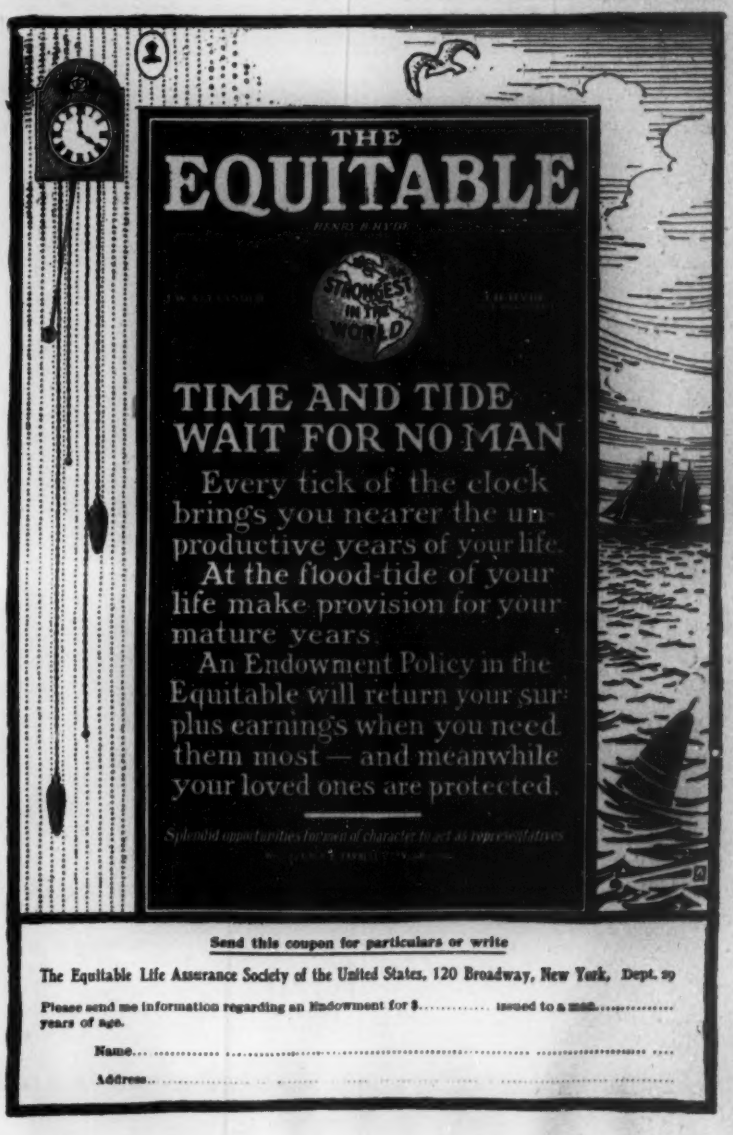
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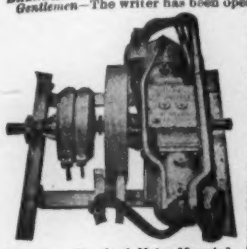

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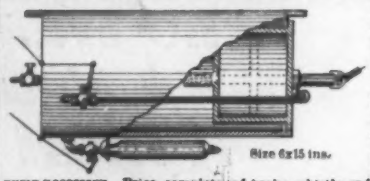

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